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EDITOR:

DR. T. H. BARRY, ALBANY MUSEUM, GRAHAMSTOWN

The hymenopterous types of Peter Cameron in the Albany Museum, Grahamstown, South Africa, *with notes on their condition*

C. JACOT-GUILLARMOD, M.Sc.

ALBANY MUSEUM, GRAHAMSTOWN.

Peter Cameron was, throughout his life, a most prolific describer of new species; his published works run into hundreds and he probably described many more hundreds of species. His monograph of British phytophagous Hymenoptera is perhaps his best work. Unfortunately, however, his descriptions leave much to be desired, especially those published towards the end of his life, for very often his work was inclined to be superficial and uncritical. In numerous cases, species which he described were assigned to the wrong genus, or even to the wrong family. All this, as well as his habit of distributing more than one specimen labeled "Type", has been the despair of many subsequent workers. In addition, Cameron does not seem to have been very careful in returning specimens sent to him for naming; in some cases, apparently, sending them back to the wrong individuals or institutions.

In view of all that has been said above, it is thought that a few remarks on those types deposited in the Albany Museum may be of some use to various workers studying Hymenoptera. It may not be inopportune to mention at this stage, that a number of the types, of species described by Cameron, have not been traced up to now. Were these ever returned by Cameron or have they been lost subsequently? It will be noticed that some of the species discussed have been listed as deposited in the Transvaal Museum, Pretoria (see "A list of Zoological and Botanical Types Preserved in Collections in Southern and East Africa"). This confusion arises from the fact that more than one specimen was marked as "Type". Seeing that these particular species were described on specimens sent by, and belonging to, the Albany Museum, it is only logical that the types will be those specimens returned to that institution, no matter what Cameron did with those he retained for his trouble. This means that those specimens returned to the Albany Museum have to be considered as the Holotypes and any other specimens, to use modern terminology, have to be considered merely as Paratypes. Thus some of the Holotypes listed by the Transvaal Museum are in reality Paratypes.

In the list that follows, each specimen has been carefully checked with regard to locality, collector's name, date of collecting and most important of all, whether Cameron's determination label is present, and of course whether this label bears the word "Type". In most cases these specimens have been considered as the Holotypes; in a few cases, however, they have been called Cotypes; this has been done for a special reason. If Cameron's descriptions are studied it will be noticed that he describes some of his species from more than one

locality. When he has done this, in every case the specimen from the first locality mentioned in the particular description is considered as the Holotype, the other specimens being considered as Paratypes, unless no specimen from the first locality is available, in which case the specimen is called Cotype. The main reason for the use of this term is that it is not known whether the other specimen or specimens are still in existence; if these others are not extant then the Albany Museum specimens can be designated as Lectotypes, one for each particular species. In some cases, the term Cotype has been used for specimens that were sent by Father O'Neil and thus were probably merely one of a series from O'Neil's collection, but here again, if no other specimen is in existence, then these may be called Lectotypes.

In listing the names, these have been placed in the family to which Cameron had assigned them, or to its modern equivalent, unless there had been an obvious misplacement. In the latter case, the particular species has been assigned to a family which is considered the correct one. The name given by Cameron is placed first followed by a reference to the original description. This is followed by a description of the various labels, condition of the specimen, and in many cases, a short discussion on synonymy, that is, where the species is placed by modern workers, when this is known, or what specific name should be used in cases of synonymy.

Family TIPHIIDAE.

Sub-family Anthoboscinae.

Odontothynnus lacteipennis Cameron 1904. Rec. Albany Mus., 1 (3): 162. Male.

This specimen has three labels as follows:—

(1) Miss M. Daly & Miss M. Sole Grahamstown IX-03.
(2) 239.
(3) *Odontothynnus lacteipennis* Cam. Type. [In Cameron's handwriting.]

A fourth, red label with HOLOTYPE ♂ *Odontothynnus lacteipennis* Cameron, has been added.

The specimen, which is glued on a card, is in fairly good condition, being complete except for the left fore tarsus and the right hind leg which are missing. The left hind leg is glued separately on the card.

As has been pointed out by Turner on several occasions, the genus *Odontothynnus* Cameron is a synonym of *Anthobosca*, as well as not being a member of the Thynnidae, where placed by Cameron. The genus *Anthobosca* will have to be split up into various genera and sub-genera, and when this is done, *Odontothynnus* will be available for one of the divisions, unless it proves to be a synonym of some other name which at present is considered as a synonym of *Anthobosca*.

Anthobosca lacteipennis (Cameron), the name by which it has to be known for the present, is different from any species as yet described, although closely allied to *bidentata* (Cameron), described in the same paper as the present one. No direct comparison between the two can be made as the type of *Odontothynnus bidentata* is not in the Albany Museum. *O. bidentata* is considered, however, to be the male of *Anthobosca natalensis* Turner, by Turner, Cameron's name having priority.

Plesia melanaria Cameron 1905. Rec. Albany Mus., 1(5):297. Female.

This specimen has three labels as follows:—

(1) Brak Kloof Feb. 1902. Mrs. G. White.
(2) 163.
(3) *Plesia melanaria* Cam. Type Cape Colony. [In Cameron's handwriting].

A fourth, red label with HOLOTYPE ♀ *Plesia melanaria* Cameron, has been added.

The specimen, which is glued on a card, has suffered somewhat, the apical three segments of the right antenna as well as the right eye having been eaten away by *Dermestes*; the right fore tarsus as well as the left hind leg (except for the coxa and the trochanter) are missing.

As suspected by Turner, this is not a *Plesia* at all but another member of the genus *Anthobosca*, fitting very well the description of *A. natalensis* Turner, as well as specimens determined as that species by Turner. Thus *melanaria* becomes a synonym of *Anthobosca bidentata* (Cameron) (*SYN. NOV.*)

As the locality Brak Kloof is mentioned time and again in Cameron's descriptions, and is not shown on maps, it will be helpful to those not familiar with place names in the Eastern Cape Province to know where this place is situated. The name Brak Kloof refers to a farm about nine miles north-west of Grahamstown, on the road to Bedford.

Sub-family Myzininae.

Plesia rufo-femorata Cameron 1905. Rec. Albany Mus., 1(5):298. Male.

This specimen has three labels as follows:—

(1) O'okiep 9.90.

(2) 174.

(3) *Plesia rufo-femorata* Cam. Type Dunbrody. [In Cameron's handwriting].

A fourth, red label with HOLOTYPE ♂ *Plesia rufo-femorata* Cameron, has been added.

The specimen is in very poor condition. Both antennae are broken off, the left with four segments remaining while the right has only one. The legs are fortunately intact except for the apical tarsal segment of the left hind leg which is missing. Both wings on the left side as well as the whole of the gaster are missing.

It is strange that Cameron added Dunbrody to his determination label as this place is not mentioned in his description, the only name given being O'okiep, as on the locality label. These two places are not even close together, O'okiep being in Namaqualand whereas Dunbrody is in the Sundays River Valley in the Eastern Cape Province.

The present species cannot be placed in *Plesia*, a synonym of *Myzinum* Latreille, a purely New World genus. For the Old World species de Saussure proposed the name *Mesa* and thus *rufo-femorata* has to be placed in de Saussure's genus. The present specimen is the same as the species so named (*rufo-femorata*) by Turner in his works on this family of Hymenoptera.

Plesia reticulata Cameron 1905. Rec. Albany Mus., 1(5):300. Male.

This specimen has two labels as follows:—

(1) Brak Kloof Jan. 95 Mrs. G. White.

(2) *Plesia reticulata* Cam. Type Brak Kloof. [In Cameron's handwriting.]

A third, red label with HOLOTYPE ♂ *Plesia reticulata* Cameron *teste* C. J. Guillarmod, has been added.

The specimen, glued on a card with the gaster separately glued on a card below it, is in poor condition. Both antennae are missing, only three segments on the left and one on the right, remaining. The right fore leg is missing as well as the tarsus of the right middle leg. Part of the thorax, at the base of the left pair of wings, has been eaten away and the left fore wing is missing.

This is another species which belongs to the genus *Mesa*. It is very close to, if not identical with, *Mesa xanthocera* (Gerst.); further study of more material from the type locality will be the only way of finally settling the identity of the species.

Myzine (Meira) violaceipennis Cameron 1905. Rec. Albany Mus., 1(5):301. Female.

This specimen has three labels as follows:—

(1) Brak Kloof Jan. 1901 Mrs. G. White.
(2) 227.
(3) *Myzine violaceipennis* Cam. Type. [In Cameron's handwriting.]

A fourth, red label with HOLOTYPE♀ *Myzine* (*Meira*) *violaceipennis* Cameron, has been added.

The specimen is in fairly good condition, with the following parts missing:—Three segments on the left and nine on the right antenna; the apical segment of the left fore tarsus as well as three segments of the right hind tarsus.

As already mentioned, *Myzine*, or more correctly *Myzinum*, cannot be used for South African species as it is purely a New World genus. The species under discussion is a typical *Meria*, a name consistently misspelt *Meira* by Cameron. The study of the type confirms Turner's opinion that *violaceipennis* is a synonym of the widely distributed *Meria rufifrons* (Fabricius). Cameron compares his species with *klugii* (Westwood), a species only distantly related which belongs to the subgenus *Macromeria*. This species should, thus, be known as *Meria rufifrons* (Fabricius).

Plesia continua Cameron 1905. Rec. Albany Mus., 1(5):299. Male.

This specimen has four labels as follows:—
(1) Brak Kloof Farm March 93. Mrs. G. White.
(2) 171.
(3) *Plesia continua* Cam. Type Cape Colony. [In Cameron's handwriting.]
(4) According to Brauns this is a *Myzine*.

A fifth, red label with HOLOTYPE ♂ *Plesia continua* Cameron, has been added.

This species is also a member of the genus *Meria*. Turner placed *continua* as a synonym of *abdominalis* Guérin, considering Cameron's species as the male of Guérin's species. For the present at least, they are being kept separate as there are more species involved than had been realised by Turner, and it seems very likely that *continua* is a valid species which has to be known as *Meria continua* (Cameron).

The specimen is in perfect condition except for the left antenna which has five segments missing.

Plesia interrupta Cameron 1905. Rec. Albany Mus., 1(5):318. Male.

This specimen has three labels as follows:—
(1) Dunbrody.
(2) *Plesia interrupta* Cotype Cam. [Not in Cameron's handwriting but probably in Father O'Neil's.]
(3) According to Brauns this is a *Myzine*.

A fourth, green label with COTYPE ♂ *Plesia interrupta* Cameron, has been added.

The specimen is in rather poor condition; only the basal segment of the gaster remains. The right hind tarsus is also missing.

This is another species which does not belong to *Plesia* but to *Meria*. It is not clear whether this specimen has even the right of being called a Cotype, as it does not have a determination label written by Cameron. It may simply be a specimen retained by O'Neil as the same as one sent to Cameron for naming. As the name *interrupta* is preoccupied in the genus *Myzinum*, of which *Plesia* is a synonym, Schultz has renamed it *discontinua*. This species should thus be known as *Meria discontinua* (Schultz).

Family POMPILIDAE

(Ceropalidae of Cameron)

Salius (Mygnimia) Pringleae Cameron 1905. Rec. Albany Mus., 1(4):221. Female.

This specimen has four labels as follows:—

(1) Kokstad May 02. Mrs. Pringle.
(2) 185.
(3) *Mygnimia Pringlei* Cam. Type Kapstad. [In Cameron's handwriting.]
(4) *Cyphononyx bruneiceps* Tasch. var. *Pringleae* det A. G. Arnold.

A fifth ,red label with HOLOTYPE ♀ *Salius* (*Mygnimia*) *Pringleae* Cameron, has been added.

The specimen is in good condition, although it has the following parts missing:—Ten segments of the left antenna; two segments of the left fore tarsus; the left middle leg as well as both hind legs have their tarsi missing except for the basal segment.

This species is now placed in the genus *Hemipepsis*. Arnold (1932:346) considers it to be a variety of *bruneiceps* (Tasch. 1869). He also places *tinctor* (Sauss. 1867) as a variety in spite of its having priority, as pointed out by Pate (1946:97). If one accepts the name as a varietal one, then it will have to be known as *Hemipepsis tinctor* var. *pringleae* (Cameron).

Salius (Cyphononyx) spilostomus Cameron 1905. Rec. Albany Mus., 1(4):222. Male.

This specimen has four labels as follows:—
(1) Brak Kloof Farm Ap. 91, and on the reverse side, Mrs. G. White.
(2) 187.
(3) *Salius spilostomus* Cam. Type Brak Kloof. [In Cameron's handwriting.]
(4) *Cyphononyx optimus* Smith det G. Arnold.

A fifth, red label with HOLOTYPE ♂ *Salius* (*Cyphononyx*) *spilostomus* Cameron, has been added.

The specimen is in good condition except for the following parts which are missing:—All the antennal segments except the basal three on the left antenna; left fore leg, tibia and tarsus; apical tarsal segment of the right middle leg; tibiae and tarsi of both hind legs. The left eye is dented in.

This species is a synonym of *Cyphononyx optimus* (Smith), a widely distributed species in Africa.

Salius (Cyphononyx) Schönlandi Cameron 1905. Rec. Albany Mus., 1(4):223. Female (not male as stated by Cameron).

This specimen has three labels as follows:—
(1) Gr Town. 1897 Dr. Becker.
(2) *Cyphononyx Schonlandi* Cam. Type Grahamstown. [In Cameron's handwriting.]
(3) *Cyphononyx optimus* Smith det G. Arnold.

A fourth, red label with HOLOTYPE ♀ *Salius* (*Cyphononyx*) *Schönlandi* Cameron, has been added.

The specimen is in good condition, except for the following parts which are missing:—Four segments of the right antenna; apical tarsal segment of both front legs as well as that of the left middle leg; apical three segments of both hind legs.

There is a slight possibility that the present specimen may not be the true holotype in that Cameron says that the species is based on a male collected by Dr. Penther in June whereas our specimen is a female collected by Dr. Becker without the month of collecting. The sex is thought not to be of very great importance as Cameron very often gives the wrong sex. The other discrepancies are not so easy to explain away, especially the month of collecting. What could have happened, of course, is that the original specimen was destroyed and the determination label was placed on some other specimen that was in the collection.

There is no doubt that the specimen dealt with here, is yet another specimen of *Cyphononyx optimus* (Smith). It may be added here that Arnold in his monograph (1932:298) synonymises four of Cameron's names under *optimus*, the two mentioned here as well as two species from Central Africa.

Pseudagenia capicola Cameron 1905. Rec. Albany Mus., 1(4):215. Female.

This specimen has three labels as follows:—

(1) Brak Kloof Mar. 95 Mrs. G. White. [This label is very faded].
(2) 204.
(3) *Pseudagenia capicola* Cam. Type Brak Kloof. [In Cameron's handwriting.]

A fourth, red label has been added, with HOLOTYPE ♀ *Pseudagenia capicola* Cameron.

The specimen is in rather poor condition, with the following parts missing:—Right antenna; two tarsal segments of the left fore leg and one on the right fore leg; apical tarsal segment of the right middle leg; tibia and tarsus of the right hind leg as well as the whole of the left hind leg except the coxa; left hind wing except the base. The gaster is glued on to the rest of the insect, apparently having been broken off.

Arnold simply quotes the original description, not having seen the type. The present species appears to be the same as, or very close to, *Pseudagenia circulifera* Arnold. It is almost certainly the same as the slight variety from Jeffrey's Bay, Cape Province, mentioned by Arnold (1934:318) in his original description. At this stage, it is thought inadvisable to synonymise Arnold's species under Cameron's as they may turn out to be very closely allied species, or perhaps races of the same species.

Salius (Priocnemis) spilocephalus Cameron 1905. Rec. Albany Mus., 1(4):222. Female (not male as stated by Cameron).

This specimen has four labels as follows:—

(1) Brak Kloof Farm Ap. 91 [and on the reverse] Mrs. White G.T.
(2) 202.
(3) *Priocnemis spilocephalus* Cam. Type. [In Cameron's handwriting.]
(4) *Pseudagenia spilocephalus* det G. Arnold.

A fifth, red label with HOLOTYPE ♀ *Salius* (*Priocnemis*) *spilocephalus* Cameron, has been added.

The specimen is in rather poor condition with the following parts missing:—Tibia and tarsus of the right fore leg; the femur, tibia and tarsus of the right middle leg; one tarsal segment of the left hind leg; the whole of the right hind leg except the coxa; the left fore wing. The right half of the thorax is covered with glue, apparently to hold the right fore wing in place. The gaster is glued in place, having been broken off.

This species is without doubt a member of the genus *Pseudagenia* as used by Arnold (1934:290). This is another case in which Cameron has mis-sexed a specimen. Arnold (1934:331) gives the reference to Cameron's original description as being that of female, with no comment, although only the male is mentioned by Cameron. This species has to be called *Pseudagenia spilocephala* (Cameron) for the present, at least. Some workers on the group have split up this genus into a number of genera, and, if their classification is followed, the present species may have to be placed under another generic name. This applies to various species now placed under the name *Pseudagenia*.

Pseudagenia kloofensis Cameron 1905. Rec. Albany Mus., 1(4):214. Female.

This specimen has three labels as follows:—

(1) Brak Kloof Mrs. G. White Feb. 1902.
(2) 220.
(3) *Pseudagenia kloofensis* Cam. Type Brak Kloof. [In Cameron's handwriting.]

A fourth, red label with HOLOTYPE ♀ *Pseudagenia kloofensis* Cameron, has been attached.

This specimen, glued on a card, is in fairly good condition with the following parts missing:—Nine segments of the left antenna; four and three tarsal segments of the left and right hind legs, respectively.

Arnold (1934:381) indicates that he has seen the type of this species although it does not have one of his determination labels. This species has been made the type of *Cyemagenia* Arnold (Arnold, 1934:380), thus it has to be known as *Cyemagenia kloofensis* (Cameron).

Salius (Cyphononyx) erythrostomus Cameron 1905. Rec. Albany Mus., 1(4):224. Female.

This specimen has four labels as follows:—

(1) Brak Kloof Ap. 94 Mrs. G. White.
(2) 197.
(3) *Salius erythrostomus* Cam. Type Brak Kloof. [In Cameron's handwriting].
(4) *Clavelia erythrostoma* det. G. Arnold.

A fifth, red label with HOLOTYPE ♀ *Salius* (*Cyphononyx*) *erythrostomus* Cameron, has been added.

The specimen is in rather poor condition, the gaster having become detached and pinned separately onto Cameron's determination label. The following parts are missing:—The left fore tibia and tarsus; the apical right tarsal segment; the apical right middle tarsal segment; the tibia and tarsus of the left hind leg as well as four tarsal segments on the right hind leg. The wings are somewhat worn, especially the left fore wing.

This species has been synonymised under *Paraclavelia crudelis* (Smith) by Arnold (1932:69) and is without doubt identical with all specimens of *crudelis* so named by Arnold in various collections which have been studied.

Salius Whiteanus Cameron 1905. Rec. Albany Mus., 1(4):220. Female, not a male as stated by Cameron.

This specimen has three labels as follows:—

(1) B. Kloof 1903 Mrs. G. White.
(2) *Salius whiteanus* Cam. Type Brak Kloof. [In Cameron's handwriting].
(3) gen. *Trichosalius* Arn. *whiteanus* Cam. det. G. Arnold.

A fourth, red label with HOLOTYPE ♀ *Salius Whiteanus* Cameron, has been added.

The specimen is in fairly good condition. The left pair of wings is glued separately on a card below the specimen. The following parts are missing:— Two segments of the right fore tarsus; the apical segment of the right middle tarsus; three segments on both hind tarsi.

One notices two discrepancies when one compares this specimen with the original description of *Salius Whiteanus*; firstly, the present specimen is a female and not a male; secondly, Cameron gives the date of collecting as November with no year, whereas on the specimen simply the year is given. In so many cases Cameron gives the wrong sex, that this does not appear to be very serious. The other diffierence is hard to explain.

This species is placed by Arnold (1936:115) in the genus *Trichosalius*, and he points out that it is very close indeed to *Trichosalius nitidiventris* Arnold, the type species of the genus, described from Algoa Bay, the description being based on a unique female. It is very likely that, when more specimens are studied, the two supposed species will have to be merged, and as the present name has priority the species will be known as *Trichosalius whiteanus* (Cameron).

Microphadnus bicolor Cameron 1905. Rec. Albany Mus., 1(4):213. Female.

This specimen has three labels as follows:—

(1) G.T. Feb. 02 Dal M.Sol [the label is cut off at the side, removing what was obviously the y in Daly and the e in Sole].
(2) 222.
(3) *Microphadnus bicolor* Cam. Grahamstown. [In Cameron's handwriting].

A fourth, red label has been added with HOLOTYPE ♀ *Microphadnus bicolor* Cameron, *teste* C. Jacot-Guillarmod.

The specimen, glued on a card, is in very poor condition. The head is glued separately

as well as the wings. The following parts are missing:— One antenna; one fore wing; two and three segments of the left and right middle tarsi respectively; the apical four tarsal segments of the hind legs, in addition to which the right hind leg is glued separately.

It is difficult to decide whether the present specimen is the true holotype as it does not have the word "type" on Cameron's label nor does it have one of Arnold's determination labels, in spite of Arnold mentioning (1937:68) that the type is in the Albany Museum. If this specimen is not the one seen by Arnold then the true type must have been destroyed after having been seen by that worker, which appears unlikely, as all the other types he had seen are accounted for. It is more likely that, as no change of name was required, Arnold decided against the addition of an extra label. This, however, does not prove that it is the type, as Cameron has not written type on his label. There are two alternatives to follow:— (1) to consider that this specimen is in actual fact the type on which Cameron based his description and that he merely forgot to include the word type on his label; (2) that the true type is lost, and thus this species requires a neotype. If a neotype is required, the obvious choice would be the specimen under discussion, as it was at least seen by Cameron and in addition is topotypical. In the above alternatives the same specimen would be considered as the type, whether holotype or neotype, and it has been thought more convenient to accept the above specimen as the holotype of *Microphadnus Bicolor*. If at a later date some other specimen is discovered which has prior claim to being called the holotype, the position can then be reviewed and the error corrected.

Anoplius Soleanus Cameron 1905. Rec. Albany Mus., 1(4):217. Female.

This specimen has four labels as follows:—

(1) Miss M. Daly and Miss M. Sole Grahamstown May 03.
(2) 218.
(3) *Anoplius soleanus* Cam. Type Grahamstown. [In Cameron's handwriting].
(4) *Paraferreola* (*sg. Eoferreola Arn.*) *Soleana* Cam. det. G. Arnold.

A fifth, red label has been added with HOLOTYPE ♀ *Anoplius Soleanus* Cameron.

The specimen, glued on a card, is in surprisingly good condition. No appendages are missing and it is almost free from dirt.

According to Pate's synopsis of Pompilid genera this species has to be known as *Eoferreola* (*Eoferreola*) *soleana* (Cameron) as the generic name *Paraferreola* is not applicable for this group of insects.

Microphadnus ? fuscipennis Cameron 1905. Rec. Albany Mus., 1(4):213. Male.

This specimen has two labels as follows:—

(1) *Telostegus fuscipennis* Cam. ♂ det G. Arnold.
(2) *Microphadnus fuscipennis* Cam. Type. Grahamstown. [In Cameron's handwriting].

A third, red label has been added with HOLOTYPE ♂ *Microphadnus ? fuscipennis* Cameron.

The above specimen is in poor condition, the following parts being lost:— one antenna; both front legs (except the coxae); the left middle tarsus; three segments of the right middle tarsus; and two tarsal segments of the right hind leg.

This species is placed by Arnold (1937:35) in the genus *Telostegus* with no comments except comparisons with a newly described species. Whether the present form is congeneric with the type species, from Europe, can only be decided after comparison, although the description appears to fit this insect very well

Planiceps ruficaudis Cameron 1905 Rec. Albany Mus., 1(4):214. Female.

This specimen has three labels as follows:—

(1) G.T. [Grahamstown] VIII 91 [could perhaps be 01]. Dr. Becker.
(2) 226.
(3) *Planiceps ruficaudis* Cam. Type Grahamstown. [In Cameron's handwriting].

A fourth, red label has been added with HOLOTYPE ♂ *Planiceps ruficaudis* Cameron.

This carded specimen is in good condition. All parts are present and in position except for one fore wing which is glued separately on the card. In addition the specimen is somewhat dusty.

It should be noted that the specimen does not have one of Arnold's determination labels although he mentions in his monograph (1935:472) that the type is to be found in the Albany Museum. Arnold places this species in the genus *Homonotus*, in which it fits very well and it should thus be known as *Homonotus ruficaudis* (Cameron).

Anoplius (Pompilogastra ?) erythrourus Cameron 1905. Rec. Albany Mus., 1(4):219. Female and male.

Under this name there are two specimens with type labels, a female and a male. These have the following labels:—

Female: This has four labels.

(1) Brak Kloof Jan. 95. Mrs. G. White.
(2) 178.
(3) *Pompilogastra ? erythroura Cam.* Type Brak Kloof. [In Cameron's handwriting.]
(4) *Psammochares ignitus* Smith ♂ det G. Arnold.

A fourth, red label has been added with LECTOTYPE ♀ *Anoplius (Pompilogastra ?) erythrourus* Cameron. *Teste* C. Jacot-Guillarmod.

Male: This has two labels.

(1) *Pompilogastra ? erythroura Cam.* Type Cape Colony. [In Cameron's handwriting.]
(2) *Psammochares ignitus* SMITH ♂ det. G. Arnold.

A third, red label has been added with ALLOTYPE ♂ *Anoplius (Pompilogastra ?) erythrourus*.

The female has been selected as lectotype for the simple reason that it has a locality label attached to it, whereas the male has no locality label except that which was added by Cameron as a determination label on which is the vague locality Cape Colony.

The condition of the specimens is as follows:—

Female: The following parts are missing: The left antenna, except the scape; the two apical segments of the right antenna; the left fore-leg, except for the coxa and the trochanter; the apical tarsal segment of the left middle leg; the whole of the right middle leg, except for the coxa and the trochanter; the tarsus of the left hind leg; the tibia and tarsus of the right hind leg.

Male: The following parts are missing: The left antenna; the apical eight segments of the right antenna; four tarsal segments of the left hind leg as well as the apical one on the right hind leg.

As suspected by Cameron, this species is the same as *ignitus* of Smith, which is placed in the genus *Afropompilus* by Arnold (1936:107). Evans, however, places the genus *Afropompilus* Arnold as a synonym of *Tachypompilus* Ashmead, a genus in which Arnold had originally placed his *Afropompilus* as a subgenus. As no exotic species are available for comparison, especially the type species of *Tachypompilus*, it is perhaps advisable to use the combination *Afropompilus ignitus* (Smith) Arnold, until the status of *Afropompilus* can be settled. As matters stand at the moment *Afropompilus* may be one of three things: a separate genus, a subgenus of *Tachypompilus* or a synonym of the latter.

Anoplius Dalyanus Cameron 1905. Rec. Albany Mus., 1(4):218. Male.

This specimen has four labels as follows:—

(1) Miss M. Daly and Miss M. Sole Grahamstown II 03.
(2) 226.
(3) *Anoplius dalyanus* Cam. Type Grahamstown. [In Cameron's handwriting.]
(4) *Epiclinotus* (Haupt) *dalyanus* Cam. det. G. Arnold.

A fifth, red label has been added with HOLOTYPE ; *Anoplius Dalyanus* Cameron.

The specimen is in perfect condition except for both fore wings being glued separately on the card on which the specimen is pinned.

In his monograph (1936:122) Arnold names this species *Epiclinotus dalyanus*; it, however, does not fit very well in the genus *Epiclinotus*, some characters coming nearer to the genus *Homonotus*. Until more specimens are known, especially both sexes, it is better to leave it in the genus *Epiclinotus* where it has been placed by Arnold.

Pompiliodes Beckeri Cameron 1905. Rec. Albany Mus., 1(4):220. Male.

This specimen has three labels as follows:—

(1) GrTown [Grahamstown] 1902 Dr. Becker.
(2) *Pompiliodes Beckeri* Cam. Type Grahamstown. [In Cameron's handwriting.]
(3) *Paracyphononyx* (*Homonotus*) *zonatus* Illiger (Variety) det G. Arnold.

A fourth, red label has been added with HOLOTYPE ; *Pompiliodes Beckeri* Cameron.

The specimen is in fairly good condition, only the following appendages are missing: Ten segments of the left antenna; the apical segment of the right middle tarsus; the apical tarsal segment of the left hind leg as well as the whole tarsus of the right hind leg.

This specimen is without doubt *Paracyphononyx zonatus* Illiger, a widely distributed species found in most parts of Southern Africa.

Anoplius whiteanus Cameron 1905. Trans. S. Afr. Phil. Soc., 15(4):228. Male.

This specimen has only one label, in Cameron's handwriting, as follows:—

Anoplius whiteanus Cam. Type Cape Colony.

A second, red label has been added with HOLOTYPE ; *Anoplius whiteanus* Cameron.

The specimen is in poor condition, part of the thorax being broken away by the pin; both antennae are missing except three segments on the left side; one middle leg and both hind legs are missing except for their coxae and trochanters. The wings are very dirty and most of the vestiture is caked with dirt.

Another specimen, also with a determination label of Cameron, is in the collection. The label is the same as for the above specimen except that it does not have the word "type" on it. This is unfortunate as this specimen is in much better condition than the one mentioned above, and in addition appears to be the one seen by Arnold. This latter fact is borne out by an additional label as follows: A *Paracyphononyx* (*P. lukombensis* Cam. 1912 is a synonym) det G. Arnold.

In his monograph (1936:441) Arnold synonymises this species under *Paracyphononyx metemmensis* (Magr.). The condition of the specimens makes it very difficult to be certain of one's determination and until the genitalia have been extracted this question cannot be settled with any amount of certainty. It is felt, however, that for the present at least *whiteanus* may conveniently be considered a synonym of *metemmensis*, thus burying a name which would probably remain as an uncertain species in the classification of this genus.

Anoplius Leppani Cameron 1905. Rec. Albany Mus., 1(4):216. Female.

This specimen has four labels as follows:—

(1) Glen Lynden Dec. 03 Miss Leppan.
(2) 198.
(3) *Anoplius Lippani* [Sic!] Cam. Type Glen Lyndon [Sic!]. [In Cameron's handwriting.]
(4) *Batozonus Lippani* [Sic!] det G. Arnold.

A fifth, red label has been added with HOLOTYPE *Anoplius Leppani* Cameron.

The specimen is in fair condition, with the following parts missing: Nine segments of the left and four of the right antenna; three segments of each fore tarsus; three segments of the right middle tarsus; four segments of the left and one of the right hind tarsus.

This species is placed as a synonym of *Batozonellus capensis* (Dahlbom) by Arnold (1937:6) and is certainly the same as all specimens seen which have been so named by Arnold. This species is widely distributed in Africa, being known from Abyssinia to the Cape Province.

Family VESPIDAE

Smithia ? rufipes Cameron 1905. Trans. S. Afr. Phil. Soc., 15(4):230. Male.

This specimen has one label as follows, in Cameron's handwriting:—

Smithia rufipes Cam. Type Brak Kloof Mrs. White.

A second, red label has been added with HOLOTYPE ♂ *Smithia ? rufipes* Cameron.

The specimen is complete except for the hind legs, the left having no tibia and tarsus and the right having only the coxa present. The left fore wing has been partly torn off, the detached portion being glued on a card placed below the specimen, on the pin.

Bequaert (1918:274) places this species in the genus *Labus*, suggesting that it may be a synonym of *Labus natalensis* (Saussure).

Eumenes rufolineata Cameron 1905. Rec. Albany Mus., 1(4):206. Male

This specimen has only one label, in Cameron's handwriting, with the following data on it:—

Eumenes rufolineata Cam. Type Dunbrody.

A second, green label has been added with COTYPE ♂ *Eumenes rufolineata* Cameron.

The specimen is in very poor condition. The gaster is missing and the head has been glued onto the thorax. In addition both hind legs are missing.

Cameron states that the species is based on the male. This may be so, but there are so many cases in which he gives the wrong sex in his description that this is no criterion. If Cameron is correct in his sexing, the head of the present specimen belongs to some other insect, as it distinctly belongs to a female, this being shown by the antennae and the colour of the clypeus. Brak Kloof is given as the first locality in the original description, so there is a possibility that this specimen is a female, and the Brak Kloof one is the actual specimen used by Cameron for his description, and in consequence a male. This uncertainty as to the sex of the specimen has been the main reason for labelling it as a male, in spite of the head being that of a female. Further, it is considered only a cotype because its locality is mentioned after Brak Kloof. If the latter specimen is lost then this will automatically become the lectotype.

Family SPHECIDAE

Cerceris nobilitata Cameron 1905. Trans. S. Afr. Phil. Soc., 15(4):216. Female.

This specimen has three labels as follows:—

(1) Dunbrody. [Presumably in Father O'Neil's handwriting.]

(2) 263.

(3) *Cerceris nobilitata* Cam. Type. [In Cameron's handwriting.]

A fourth, red label has been added with HOLOTYPE ♀ *Cerceris nobilitata* Cameron.

The specimen is in good condition.

The locality label makes it obvious that this specimen was collected by Father O'Neil, and therefore one would think that the type would be together with the other types in the O'Neil collection, which is not in the Albany Museum. This specimen, however, is considered as the holotype for two reasons: (1) the number 263 is printed in the same manner as all the others on specimens sent to Cameron by the Albany Museum. It would thus appear that this specimen, although collected by O'Neil, was not sent to Cameron by him but by the Albany Museum; (2) Brauns (1926:313) mentions that the type is in the Albany Museum.

This latter point does not carry much weight as Brauns may have simply taken it to be the type, seeing it bears a label with the word "type" on it. Under the circumstances, it is thought best to consider the above specimen as the holotype, at least until some other specimen can be proved to have prior claim to this title.

Cerceris whiteana Cameron 1905. Trans. S. Afr. Phil. Soc., 15(4):225. Female.

This specimen has two labels as follows:—

(1) B. Kloof 1893 Mrs. G. White Brak Kloof [on reverse side].

(2) *Cerceris whiteana* Cam. Type. [In Cameron's handwriting.]

A third, red label has been added with HOLOTYPE ♀ *Cerceris whiteana* Cameron.

The specimen is complete except for the right fore wing which is missing.

Brauns (1926:336) considers this species as a synonym of *Cerceris spinicaudata* Cameron, a widely distributed species in Southern Africa.

Hoplisus Whitei Cameron 1905. Rec. Albany Mus., 1(4):210. Male.

This specimen has three labels as follows:—

(1) 248.

(2) Brak Kloo IV-01 Mrs. G. Whi [When the label was cut part of the writing was cut away.]

(3) *Hoplisus whitei* Cam. Type Cape Colony. [In Cameron's handwriting.]

A fourth, red label has been added with HOLOTYPE ♂ *Hoplisus Whitei* Cameron.

Below this there is another label with the following written on it:— = *H(Gorytes)thalia* Handl. *fide* Brauns. [It is not known in whose handwriting this last label is.]

This name does not appear in Arnold's monograph of the Sphegidae but is to be found in Maidl and Klima (Hym. Cat., 8:89. 1939) as a good species. According to Arnold's classification, *whitei* would come into the genus *Gorytes*. Maidl and Klima place it in the subgenus *Hoplisoides*, together with *thalia* Handl. From the above transcriptions of the labels it is evident that Brauns had seen the specimen and considered it conspecific with *thalia*. No exhaustive comparisons have yet been made between this specimen and males of *thalia*, but all indications point to *whitei* being a synonym of *thalia* or a species very close to it.

Ampulex spiloptera Cameron 1905. Rec. Albany Mus., 1(4):254. Female.

This specimen has three labels as follows:—

(1) Dunbrody 1/3/01.

(2) *Ampulex spiloptera* Cameron Cotyp. [*Not* in Cameron's handwriting].

(3) — colour variety of *nigrocoerulea* Sauss with coarser puncturation on head and mesonotum det G. Arnold.

A fourth, green label with COTYPE ♀ *Ampulex spiloptera* Cameron, has been added.

The specimen is in good condition except for the following parts which are missing:— half the femur, the tibia and the tarsus of the left middle leg; the tarsus of the left hind leg.

There is a possibility that Cameron never saw this specimen seeing that the det. label is not in his handwriting. There is the possibility also that he returned more than one specimen to Father O'Neil, having labelled only one of them, and when the latter donated the unlabelled specimen to the Albany Museum, a label was added to make it clear that the specimen was one of the type-series. It is not known whether the holotype of this species is still in existence, if not then this specimen could either be selected as lectotype or neotype, depending on whether it can be proved that Cameron saw the specimen or not.

Ammophila erythrospila Cameron 1905. Rec. Albany Mus., 1(5):303. Male.

This specimen has three labels as follows:—

(1) Glen Lynden Jan 02 Miss Leppan.
(2) 214.
(3) *Ammophila erythrospila* Cam. Type Cape Colony. [In Cameron's handwriting.]
A fourth, green label has been added with COTYPE ♀ *Ammophila erythrospila* Cameron.

The specimen is in poor condition. Both antennae have only three segments left, while both fore legs are broken off, leaving only the left coxa and the right coxa and femur. The right hind leg has the tarsus broken off, while the gaster is completely missing except for the petiole.

The above specimen is not considered the holotype due to the fact that the first locality mentioned in the original description is Table Farm, the above mentioned locality being mentioned in second place. It is not known where the Table Farm specimen is, if still in existence. If it should prove to be lost then this specimen may be considered as the lectotype.

Arnold (1928:276) considers this species as a synonym of *Ammophila bonae-spei var. ferrugineipes* Lepeletier, a widely distributed form. It should be noted that the generic name *Sphex* is used by Arnold in his monograph for this genus. *Ammophila* has now, however, been placed in the official list of generic names. It is thus a pity that some American workers still insist on using *Sphex* for this genus and not for that for which Arnold used the name *Chlorion* in his monograph. This inconsistency is causing a lot of confusion among workers on the Sphecinae.

Palarus lineatifrons Cameron 1905. Trans. S. Afr. Phil. Soc., 15(4):213. Female.
This specimen has three labels as follows:—
(1) Somerset East VI-01. Mrs. G. White.
(2) 229.
(3) *Palarus lineatifrons* Cam. Type Cape Colony. [In Cameron's handwriting.]
A fourth, red label has been added with HOLOTYPE ♀ *Palarus lineatifrons* Cameron.

In addition to the above there is another label with the following on it: [illegible] *P. latifrons* Kohl *fide* Brauns.

The specimen is in poor condition. Both the antennae are missing. The right side of the thorax has been eaten away. There is no tarsus on the left middle leg while the right leg is completely missing. The left hind leg is broken off at the coxa.

Arnold (1923:5) places this species as a synonym of the common Banded Bee-pirate (*Palarus latifrons* Kohl).

Oxybelus ruficaudis Cameron 1905. Rec. Albany Mus., 1(4):208. Female.
This specimen, glued on a card, has two labels as follows: -
(1) Miss M. Daly and Miss M. Sole Grahamstown. II-03.
(2) *Oxybelus ruficaudis* Cam. Type Grahamstown. [In Cameron's handwriting.]
A third, red label has been added with HOLOTYPE ♀ *Oxybelus ruficaudis* Cameron.

The specimen is in good condition, having only the apical three segments of the right middle leg missing.

This species is common and widely distributed throughout Southern Africa.

Oxybelus capensis Cameron 1905. Rec. Albany Mus., 1(4):209. Male.
This specimen has three labels as follows:—
(1) Brak Kloof Feb. 96 Mrs. G. White.
(2) 44.
(3) *Oxybelus capensis* Cam. Type Brak Kloof. [In Cameron's handwriting.]
A fourth, red label has been added with HOLOTYPE ♂ *Oxybelus capensis* Cameron.

This specimen is in very poor condition. The gaster is glued separately on a card below the rest of the specimen. The head is missing and the wings are caked with dirt.

Arnold (1927:89) places this species as a synonym of the previous one, *Oxybelus ruficaudis* Cameron.

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R. A. JUBB, B.Sc.

DEPARTMENT OF ICHTHYOLOGY,
RHODES UNIVERSITY.

The Freshwater Eels (*Anguilla spp.*) of Southern Africa. An introduction to their identification and Biology.

SUMMARY

Five species of freshwater eels have been found in the rivers of South Africa, *Anguilla marmorata* Quoy and Gaimard, 1824, *Anguilla nebulosa labiata* Peters, 1852, *Anguilla mossambica* Peters, 1852, *Anguilla obscura* Gunther, 1871, and *Anguilla bicolor bicolor* McClelland, 1844. These are described and a simplified key provided for their identification.

The distribution of the two predominant species *A. nebulosa labiata* and *A. mossambica* is associated with zones on the African coast where elvers of these species reach the river mouths; between the equator and 21 S. in the case of the former, and between 21 S. and 32 S. in the case of the latter species. The dispersal of these two species over a river system appears to be governed by the size of the eel reaching the river mouth and not by water temperature or any particular environment. Distribution outside these elver zones is carried out at sea by post-elvers, and a considerable wandering along the coastal shelf takes place.

Elvers of *A. mossambica* reach the Natal coast in January, and those of *A. nebulosa labiata* and *A. bicolor bicolor* have been reported from the coast of East Africa in January and February. Mature silver male and female *A. mossambica* leave the South African rivers during the period November to March, during which period mature silver female *A. marmorata*, *A. nebulosa labiata* and *A. bicolor bicolor* have also been discovered. Secondary migrations by post-elvers up the rivers of the South-east Cape and Natal are observed during the period January to April.

A length-weight curve for the material on hand is provided, also a histogram showing the change of feeding habits with increase in size.

A hypothetical breeding place for the eels of the West Indian Ocean is discussed in relation to the sea currents of this area, and an indirect route possibly taken by post-elvers reaching the south-east and south coast rivers described.

The economic exploitation of eel populations is discussed briefly, and it is pointed out that whilst the annual supply of elvers from the sea is a permanent natural resource, the exploitation of eel populations from these elvers is related to the permanency and availability of inland waters.

THE FRESHWATER EELS (*ANGUILLA* SPP.) OF SOUTHERN AFRICA. AN INTRODUCTION TO THEIR IDENTIFICATION AND BIOLOGY

Up to only three years ago relatively little was known about the freshwater eels of Southern Africa. Scarcely any biological or ecological investigations of note had been carried out,

and the systematic picture had been obscured by the opinions of remote authorities. For these reasons, when I joined the Department of Ichthyology at Rhodes University, Professor J. L. B. Smith suggested the investigation of the eels as my first assignment. The results set out below summarise the advances in knowledge that have resulted, and the position to date.

The first work of any note on the freshwater eels of the area of the Western Indian Ocean was done by Peters (1), who, in 1852, described four species of freshwater eels from Portuguese East Africa. These were two mottled eels *Muraena* (*Anguilla*) *macrophthalma* and *Muraena* (*Anguilla*) *labiata*, a plain long-finned eel *Muraena* (*Anguilla*) *mossambica*, and a plain short-finned eel *Muraena* (*Anguilla*) *virescens*. *M.* (*Anguilla*) *macrophthalma* has since proved to be the mature male of the species *M.* (*Anguilla*) *labiata*. Subsequent to this other workers named varieties of mottled eels and plain eels from the Indian Ocean, and by the time Gilchrist and Thompson (2) published their work in 1917, there was considerable confusion about the species found in the rivers of Southern Africa. These two authors recognised Peter's *Anguilla mossambica*, but assigned *M.* (*Anguilla*) *labiata* and *M.* (*Anguilla*) *macrophthalma* to *Anguilla bengalensis* Gray, 1830, and the short-finned eel *M.* (*Anguilla*) *virescens* to *Anguilla australis* Richards, 1841. Further confusion arose when the late Professor J. Schmidt, who had initiated a world-wide investigation into the biology of the freshwater eels, examined a number of specimens of South African eels and stated that they were all of one species, *Anguilla mossambica*.

Dr. Vilh Ege carried on with Schmidt's work, and his "Revision of the Genus *Anguilla* Shaw" (3), published in 1939, placed the systematics of the freshwater eels of the world on a sound basis. In addition to collecting and examining fresh material Ege was able to examine all existing types, and the final outcome of this classic research was the reduction of 70 described species to a total of 16.

The freshwater eels were divided into four distinct groups:—

(1) Species with mottled skin pattern and long dorsal fin, and in which the maxillary teeth are in several rows close together.
(2) Species with mottled skin pattern and long dorsal fin, and in which the maxillary teeth have a distinct longitudinal groove.
(3) Species with plain unmottled skin and long dorsal fin.
(4) Species with plain unmottled skin and short dorsal fin.

These groups, which must refer to specimens of greater than 20 cm. in length, were subdivided principally on dimensions, dentition and vertebral counts. As shown in figure 1, the important dimensions are the pre-anal (A), pre-dorsal (D), length of head (E), and the total length (L) of the eel. These are measured as shown in figure 1 and the ano-dorsal distance (A—D) is expressed as a percentage of the total length L. Thus long-finned eels give average values of 10 to 20 per cent, and short-finned eels values of − 3 to − 5 per cent. The negative values signify that the dorsal fin originates behind the vertical through the anus.

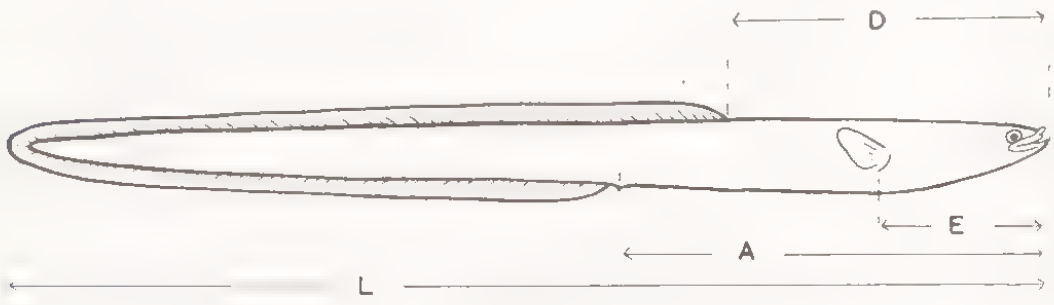


Fig. 1. Dimensions of Eel

Anguilla nebulosa labiata Peters, 1952.
African Mottled Eel, Specimen (108 cm.) taken in the Umzimkulwana River, Natal.

Based on Ege's detailed characteristics five species of eels have been found in the rivers of South Africa (4), (5), (6). These can be assigned to the broad groups 2, 3 and 4 above. A simplified key for their identification would be as follows: –

Key to the Species of *Anguilla* found in South African Rivers.

A. Specimens of 20 cm. total length and over:—

1. Distinct mottled skin pattern on dorsal surface, extending to ventral surface posterior of the anus; mottled skin pattern dark and diffuse on dorsal surface in very large specimens; dorsal fin long; maxillary teeth with distinct longitudinal groove.

1.1. Ano-dorsal length 14 to 19 per cent of total length (fig. 9); vertebral count 103 to 108 (fig. 2); longitudinal groove in maxillary teeth extends to posterior end of band (fig. 4). *Anguilla marmorata* Quoy & Gaimard, 1824.

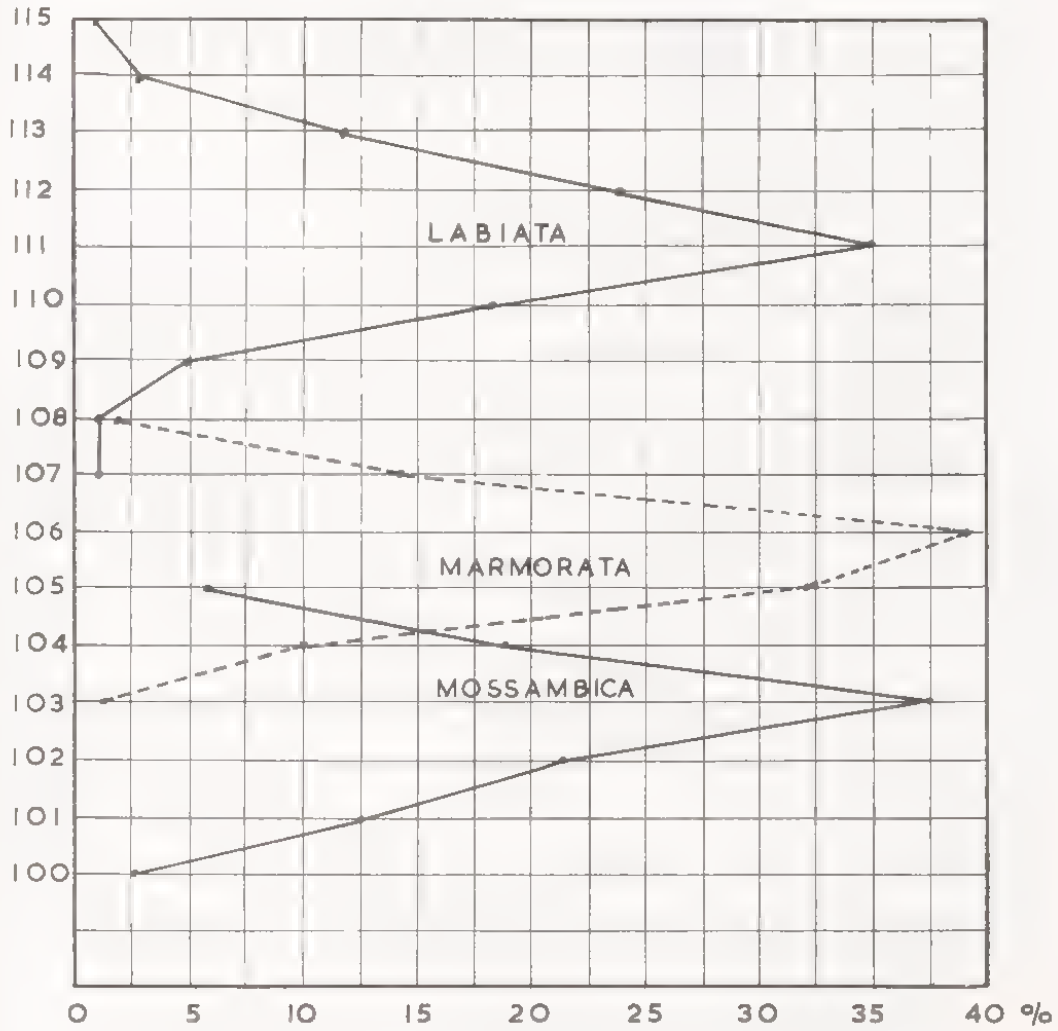


Fig. 2. Percentage frequency of total number of vertebrae. (After Jespersen).

1.2. Ano-dorsal length 7 to 15 per cent of the total length (fig. 9); vertebral count 107 to 115 (fig. 2); longitudinal groove in maxillary teeth does not extend to hindermost tip of band (fig. 5). *Anguilla nebulosa labiata* Peters, 1852.

2. Skin without mottled pattern; maxillary bands of teeth in several rows and without longitudinal groove (fig. 6).

2.1. Ano-dorsal distance 9 to 17 per cent of the total length (fig. 9); vertebral count 100 to 105 (fig. 2). *Anguilla mossambica* Peters, 1852.

2.2. Ano-dorsal length 1 to 5 per cent of the total length; vertebral count 102 to 107 (fig. 3); length of intermaxillary-vomerine band of teeth 70 to 80 per cent of the length from the front end of this band to the posterior tip of the right maxillary band (fig. 7). *Anguilla obscura* Gunther, 1871.

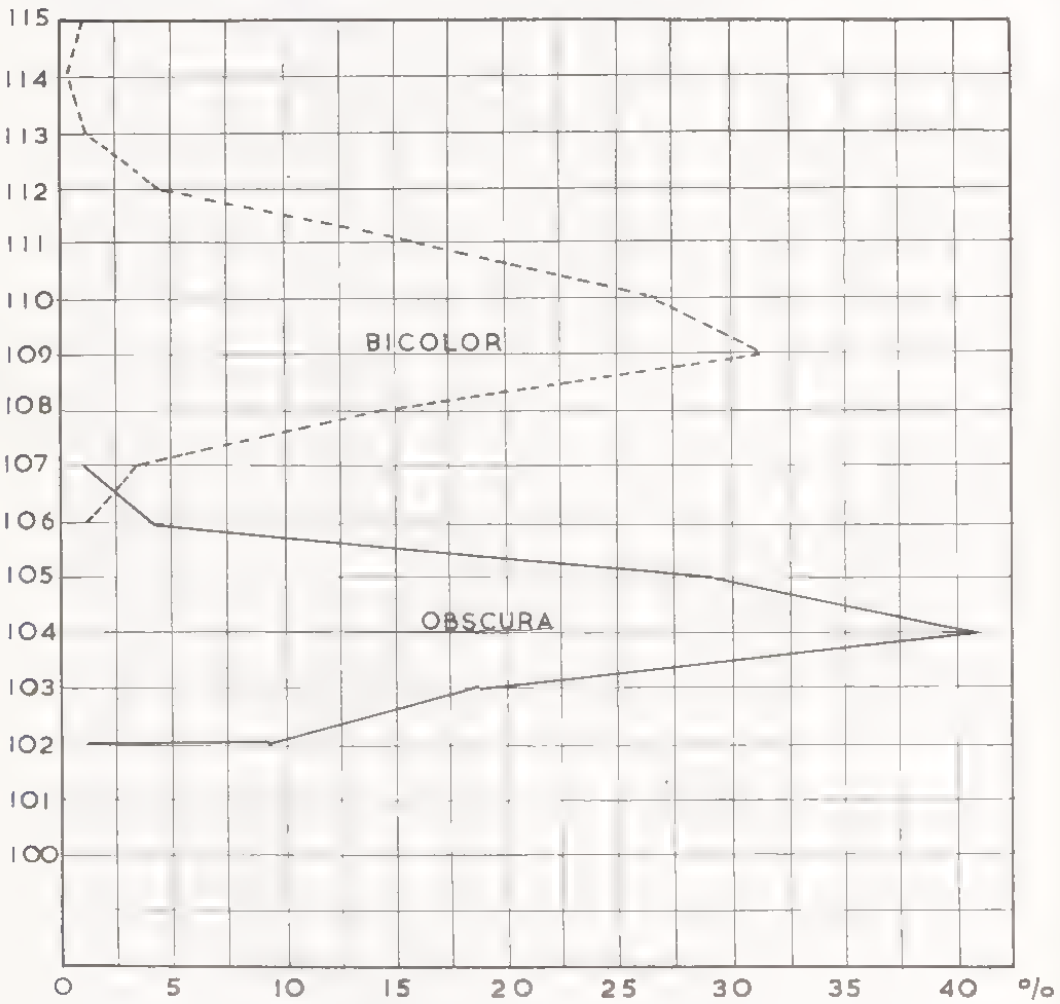


Fig. 3. Percentage frequency of total number of vertebrae. (After Jespersen

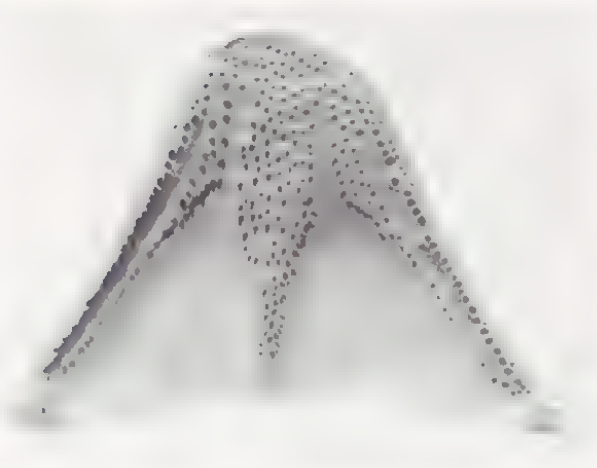


Fig. 4. *Dentition A. marmorata*

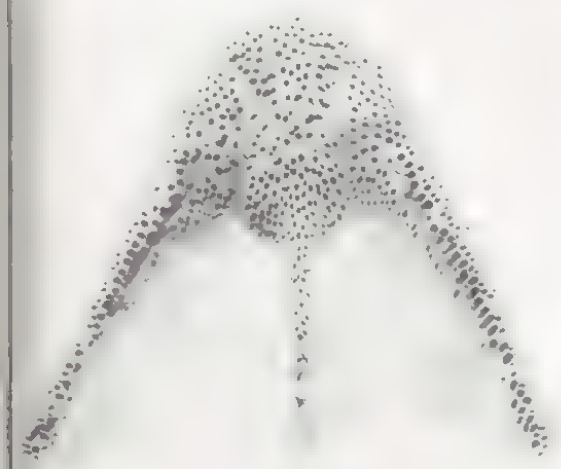


Fig. 5. *Dentition A. nebulosa labiata*

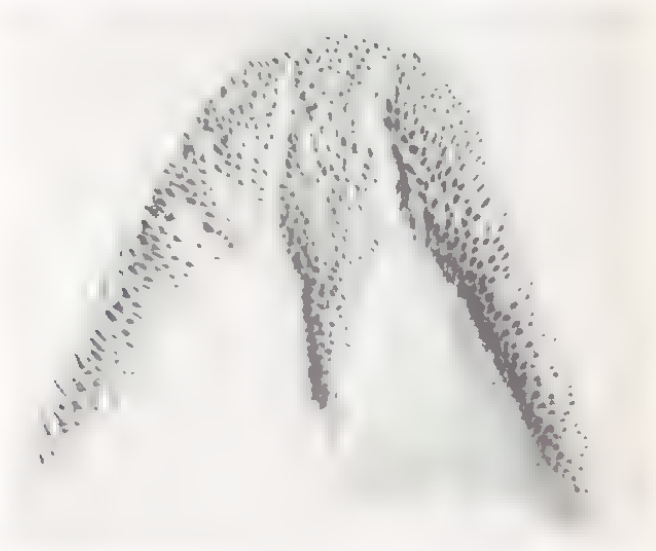


Fig. 6. *Dentition A. mossambica*

2.3. Ano-dorsal distance —1 to +3 per cent of the total length; vertebral count 106 to 115 (fig 3); maxillary band of teeth broad; length of intermaxillary-vomerine band of teeth 85 to 95 per cent of the length from the front end of this band to the posterior tip of the right maxillary band (fig. 8). *Anguilla bicolor bicolor* McClelland, 1844.

B. Specimens of less than 20 cm. in length:—

In the case of small eels the dentition is not fully developed, and the mottled pattern difficult to discern in eels of less than 15 cm. What pattern there is is in the form of blotches rather than a distinct pattern. It is possible to separate the long-finned eels from the short-finned

eels by the ano-dorsal values. It would also be possible to separate young of *A. marmorata* from those of *A. nebulosa labiata* by the ano-dorsal values, but where dentition and skin pattern cannot be used, as in the case of very small eels, the presence of young of *A. mossambica* would confuse the issue. This is shown in fig. 9. In this investigation the identification of small specimens has been carried out by sorting the material into extremes of ano-dorsal values, dissecting, staining with alizarine, clearing and counting the vertebrae with the aid of a microscope. Only in the case of *A. mossambica* was there abundant material, so the use of the pigment pattern on the caudal could not be used with any confidence to detect specimens of the other long-finned species from a batch of small eels.

Fig. 7. *Dentition A. obscura*

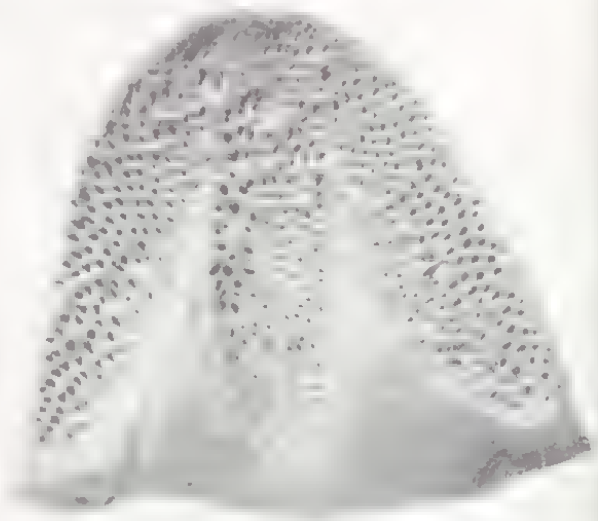


Fig. 8. *Dentition A. bicolor bicolor*

DESCRIPTIONS

Anguilla marmorata Quoy & Gaimard, 1824.

Common names: Mottled eel, Conger eel (Eastern Cape), Geelbonte paling, Swartwitpens paling.

Ege records the following synonyms:—

A. mauritiana Bennett, 1831. *A. labrosa* Richardson, 1844. *Muraena maculata* Bleeker, 1864. *Muraena manillensis* Bleeker, 1864. *Anguilla johannae* Playfair & Gunther, 1866. *Anguilla fidjiensis* Gunther, 1870. *Anguilla hildebrandti* Sauvage, 1891. *Anguilla bengalensis* Reuvens, 1895.

A. marmorata is an Indo-Pacific species with a very wide distribution in the west Indian Ocean. The first specimens of this species to be examined during this investigation came from the Kaffrarian Museum (7), but later specimens were collected in the Sundays River, the Buffalo River, and the Sabi-Lundi River system, Southern Rhodesia (8). Material in the South African Museum came from the Bashee River, Transkei. Frost (9) reports a specimen of 127.0 cm. from the Lusemfwa River, Zambezi River system. Altogether 17 specimens

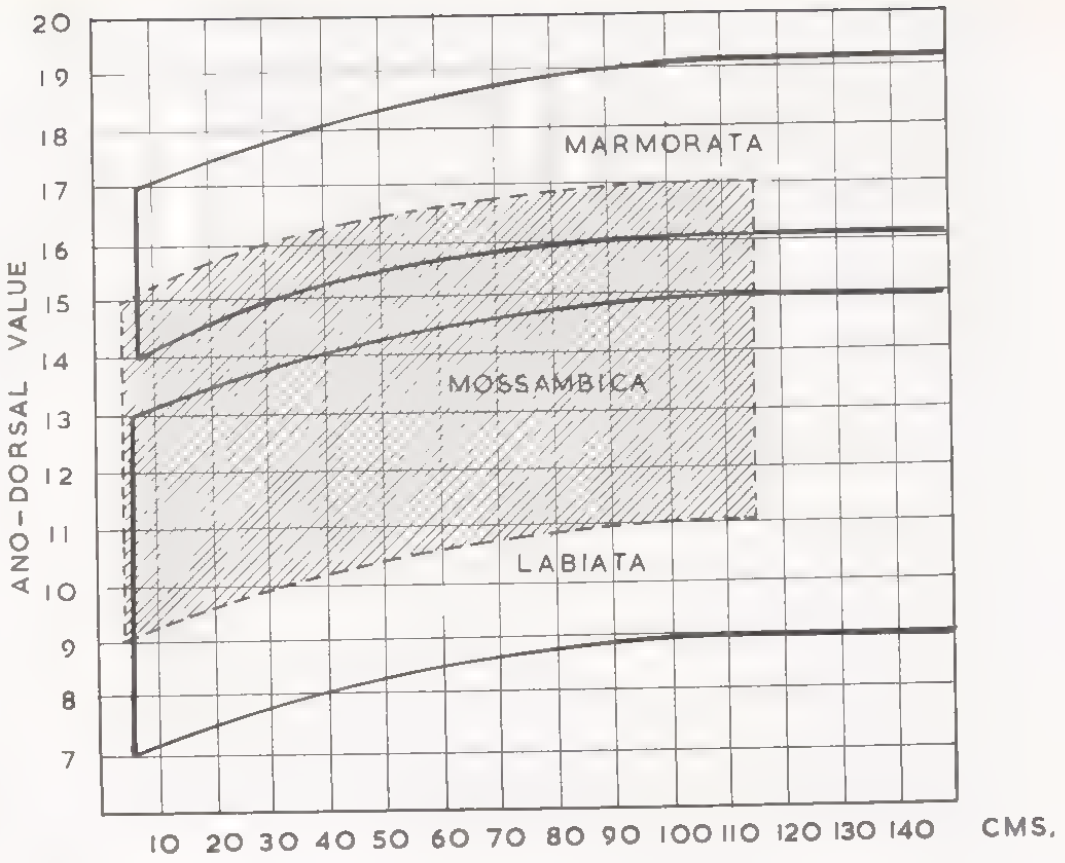


Fig. 9. Block diagram enclosing scatter points for values of anodorsal distance, expressed as a percentage of total length, for *A. marmorata*, *A. nebulosa labiata* and *A. mossambica*. This diagram shows how values for *A. mossambica* overlap, for all ranges in size, those of the other two long-finned eels.

have been examined covering a range of 17.7 cm. to 134.0 cm. in length. Some very heavy mottled eels have been caught by anglers in the Keiskama River, and the Transkei rivers, and weights of up to 45 lb. claimed. Very large eels are also caught in the lowveld rivers of Natal and the Eastern Transvaal. From photographs examined these would be either *A. marmorata* or the next species, *A. nebulosa labiata*; both species attain 183.0 cm. in length.

Although very similar, the colour pattern of *A. marmorata* is not as bold as that of *A. nebulosa labiata*. (fig. 10 and fig. 11.) *A. marmorata* has a mottled pattern of dark brown-green on a background of olive-yellow which extends from the top of the head anteriorly and covers the whole body posterior of the anus, pronounced in the dorsal fin but faint in the anal fin, the belly is pale yellow. A mature female eel of this species, which was taken in the Sundays River at Addo, was nearly uniformly dark brown-green on the dorsal surface with a silvery pink belly, the mottled pattern was only evident on the sides of the head and body. This particular specimen was recognised by an experienced eel angler of Addo by the common name of swartwitpens paling, the black white-bellied eel.

As indicated in fig. 9 the ano-dorsal values cover a range of 14 to 19 per cent of the total

Fig. 10. Skin pattern *A. marmorata*

Fig. 11. Skin pattern *A. nebulosa labiata*

length with a tendency to increase with the size of the eel. The vertebral counts of six specimens gave a range of 105 to 106. Dentition patterns were taken of all specimens, using plasticine. These showed quite clearly the distinct longitudinal groove in the maxillary teeth bands. The pattern shown in fig. 4 is typical of the specimens examined.

No male specimens of *A. marmorata* have been found during this investigation; of those which could be sexed all have been found to be females.

South of the Limpopo River *A. marmorata* is confined to the deep pools of flowing

rivers above the ebb and flow and some 10 to 50 miles inland. The largest specimens are taken by anglers at, or near, the ebb and flow, and occasional specimens are taken in the tidal sections of these rivers. In Southern Rhodesia *A. marmorata* was taken 230 miles inland by river from the sea; the specimen reported by Frost (9) was taken approximately 600 miles inland.

Anguilla nebulosa labiata Peters, 1852. (Plate I.)

Common names: Mottled eel, Conger eel (East Cape), Geelbonte paling.

Synonyms:—

Muraena (*Anguilla*) *macrophthalma* Peters, 1852.

As will be seen from the common names this eel is generally confused with the previous species, *A. marmorata*. The mottled pattern is, however, bolder than that of *A. marmorata*. In specimens taken from muddy water the colouring is much lighter and the background colour yellow; those taken from deep rocky pools with clear water have been found to be very dark but with distinct mottled pattern. A mature female from the Loskop Dam, Olifants River, Transvaal, forwarded by the Lydenburg Fisheries Institute was uniformly very dark on the dorsal surface with mottling on sides. In specimens of 13 cm. collected in the lower Lundi River, Southern Rhodesia the mottling was discernible as a blotchy pattern.

Altogether 47 specimens were collected and examined, and these, together with the dimensions of 63 kindly forwarded by Dr. Frost, 3 presented by R. Boltt, and the statistics of 119 extracted from Ege, give an ano-dorsal distance range of 7 to 15 per cent of the total length, with a peak frequency range of 11 to 13 per cent. As shown in fig. 9 these ano-dorsal values overlap those of *A. mossambica*, but elvers and small post-elvers can be separated positively by vertebral counts.

Vertebral counts made from fresh material fell between the range 109 to 112. The dentition pattern is very similar to that of *A. marmorata*, and the termination of the longitudinal groove posteriorly in the maxillary teeth is not always as clearly defined as in fig. 5. In specimens less than 16 cm. in length it has not been possible to determine the dentition pattern with confidence.

No male specimen of this species has been found in South African rivers. A mature male of 59 cm. was presented by R. Boltt; this was collected near Chirundu, Zambezi River, during September 1959.

Frost (10) has shown that *A. nebulosa labiata* is the predominant species of eel in the rivers of Kenya. This author found the same to be the case when examining eels from Northern Rhodesia (9). It is the only species reported from Lake Nyasa (11) and the trout streams of the Inyanga Mountains, Southern Rhodesia (12). Field work in this latter area showed this to be the case in the Gairezi River, Zambezi system, and the Pungwe River. South of this area the distribution of *A. nebulosa labiata* extends southwards along the coast and round to as far west as Knysna, but as we come southwards the numbers decrease and this eel is found nearer and nearer to the sea. West of Knysna occasional mottled eels are reported from the lower reaches of the Goukamma and Breede Rivers; these may be *A. nebulosa labiata*, or the previous species *A. marmorata*.

Anguilla mossambica Peters, 1852.

Common names: Plain long-finned eel. Black eel. Rock eel. Paling. Geelbek paling (South-Western Cape). Swart paling.

Synonyms:—

Anguilla delalandi Kaup, 1856. *Anguilla capensis* Kaup, 1859.

This is the common eel of South African rivers. The colour varies from a uniform slate to dark chocolate-brown on the dorsal surface, extending to the whole body posteriorly, lighter on sides, with silvery yellow belly. Mature eels have a very dark bronze dorsal surface

and sides, with silvery iridescent pink belly. Excluding true elvers, 1,454 specimens were examined covering a range of 8.7 cm. to 122 cm. in length. The heaviest eel of this species examined during this investigation weighed 10 lb. 8 oz.; the more common weight was 5 to 7 lb. Where free to move up or downstream, *A. mossambica* is undoubtedly a much smaller eel than either of the two mottled eels *A. marmorata* or *A. nebulosa labiata* and records of weights in excess of 20 lb. are almost certainly due to a misidentification of the species.

The ano-dorsal distances had a range of 9 to 17 per cent of the total length (fig. 9). The dentition pattern (fig. 6) is quite distinct from that of the other two long-finned eels. Samples covering the whole distribution range in southern Africa were dissected for vertebral counts and these gave a range of 100 to 104.

Field work has shown that *A. mossambica* is the predominant eel from the Sabi-Lundi River system in Southern Rhodesia, southwards to the south coast and as far west as Knysna. West of Knysna the numbers decrease, the Breede River being the furthest west where it is found in fair numbers. Occasional specimens are reported from the vicinity of Cape Town.

Material examined in the South African Museum included a large *A. mossambica*, S.A.M. 12761, from the confluence of the Caledon and Orange Rivers. The McGregor Memorial Museum, Kimberley, has another specimen taken from the Vaal River near that town (13). For reasons to be discussed later, it is considered that these occasional *A. mossambica* that enter the Orange River system, do so by an overland route from the Limpopo River system.

Anguilla obscura Gunther, 1871.

A single specimen of 35.5 cm., which has been assigned to this species, was collected in a tributary of the Buffalo River, near King William's Town, on the 8th of August, 1957 (5). Being a short-finned eel it was easily separated from the *A. mossambica* collected at the same time. Being very dark in colour this eel was examined critically. The dentition pattern (fig. 7) differed greatly from that of the better-known *A. bicolor bicolor* (fig. 8), the length of the intermaxillary-vomerine band of teeth being 73 per cent of the distance from the front margin of that band to the posterior end of the right maxillary band. The ano-dorsal distance was 2.4 per cent of the total length, and the vertebral count 103. In direct comparison there is a very great difference in colour between this specimen and specimens of *A. bicolor bicolor*; the former is generally dark slate with lighter belly, and the latter are olive-grey. The gonads were not sufficiently developed to determine the sex with any certainty.

As this was the first record of this species in the Indian Ocean a careful search has been made for additional specimens, but, to date, none has been found.

Anguilla bicolor bicolor McClelland, 1844.

Common name: Short-finned eel.

Synonyms:—

Muraena (*Anguilla*) *virescens* Peters, 1852. *Anguilla dussumieri* Kaup, 1856. *Anguilla cantori* Kaup, 1856. *Anguilla amblodon* Playfair & Gunther, 1866. In the works of Boulenger 1915, and Gilchrist & Thompson 1917, this species has been referred to as *Anguilla australis* Richardson, 1841.

This eel is widely distributed over the Indian Ocean, and along the coast of Africa; although not common, it has been collected from Knysna to the Sabi-Lundi River system in Southern Rhodesia. Frost (10), (14) reports this species from the rivers of Kenya. In South Africa and in Kenya *A. bicolor bicolor* has been found near the sea, but it is interesting to record that 4 specimens were collected in the Lundi River, Southern Rhodesia, in May 1958, at a site 190 miles by river from the sea, altitude approximately 900 feet.

The material examined covers two specimens, 58.0 and 60.0 cm. in length from the Seychelles, a single specimen from Zanzibar Island 62.0 cm. in length, all collected by Prof.

J. L. B. Smith, a specimen of 64.0 cm. from Zululand presented by Mr. L. van Heerden, 4 forwarded by the Kaffrarian Museum, and 10 collected during field work. A live specimen in the aquarium of the Lydenburg Provincial Fisheries Institute has been inspected. In colour, this latter specimen, like Mr. van Heerden's, has the dark colour of an eel approaching maturity. Preserved specimens are light olive-brown in colour with a very light belly. Live specimens were olive with very light underparts.

Anguilla bicolor bicolor is easily recognised by its short dorsal fin: the ano-dorsal distance, in the material on hand, is 0 to 1 per cent of the total length. The broad bands of the maxillary teeth are quite different from the maxillary teeth of the specimen assigned to *A. obscura*, this can be seen by comparing fig 7 and fig. 8. The length of the intermaxillary-vomerine band of teeth is 90 to 95 per cent of the distance from the front margin of that band to the posterior end of the right maxillary band. Vertebral counts gave values of 108 to 110.

Of those specimens which could be sexed, all were females. The Zululand specimen of 64.0 cm., 1 lb. 1 oz. in weight, is a mature female with large gonads.

Anguilla anguilla Linnaeus, 1758.

Although not included in the key for South African species of *Anguilla*, mention must be made here of the fact that Ege (3) records 6 specimens of *A. anguilla* from East Africa, exact locality unknown, and three specimens from Nairobi, again exact locality unknown. Similar in general appearance and dentition to *A. mossambica*, *A. anguilla* has a vertebral count which averages 115 and falls within the range of 110 to 119, well beyond the limits of the vertebral count for *A. mossambica*. Frost (10) obtained no specimens of *A. anguilla* in Kenya, and no specimens of *Anguilla* have been found in South African rivers which can be assigned to this species. It is, however, essential to examine critically those eels resembling *A. mossambica* and having a very low ano-dorsal distance.

LIFE HISTORY OF THE EUROPEAN EEL, *Anguilla anguilla*

Due to its great economic importance in western Europe, a considerable amount of research work has been carried out and published on the life history of the European eel, *Anguilla anguilla*. Based on the researches of the famous Danish oceanographer, the late Professor Johannes Schmidt, Bertin (15) has summarised the life history of *A. anguilla* as follows:—

(*a*) Marine larval phase, or phase of dispersal lasting two or three years.
(*b*) First metamorphosis, leptocephalus into elver.
(*c*) Phase of growth in fresh water, lasting 8 to 18 years, the yellow eel.
(*d*) Second metamorphosis, yellow eel into silver eel, migration to the sea.
(*e*) Adult marine phase, or phase of reproduction, of unknown duration.

From the study of the marine larval stages Schmidt located a spawning area for *A. anguilla* in the centre of the Sargasso Sea. In piecing together the evidence at his disposal Schmidt had to contend with two problems –the spectacular migration of some 3,500 miles by mature eels from the rivers of Europe and North Africa to this spawning area, and the fact that the North American eel, *A. rostrata*, also appeared to spawn in the same region. Schmidt then came to the conclusion that the duration of pelagic life during marine dispersal was finally responsible for separating the species. These two eels are very similar in characteristics until we come to the vertebral count, in *A. rostrata* the vertebral count ranges from 103 to 111, and in *A. anguilla* it is 110 to 119.

Dr. D. W. Tucker (16), (17) has re-examined all available evidence regarding the life history of these two eels and has propounded a theory of his own. In brief, Tucker considers that the European silver eel is too degenerate to complete the long migration back to the spawning area in the Sargasso Sea, and that the North American eel is in a much better condition to carry out the shorter migration required of it. He then assumes, with qualifying

evidence, that the European eel, *A. anguilla*, and the North American eel, *A. rostrata*, are one and the same species, and attributes the difference in vertebral count to larval environment, the larvae having originated from American parents.

Life History of South African Eels

There is sufficient evidence from this investigation and the published results of other research workers, to show that the five important phases in the life history of *A. anguilla* are applicable to the species of *Anguilla* found in the rivers of southern Africa. As these species can be separated by other characteristics as well as vertebral counts, and as there are hypothetical breeding grounds within reasonable reach, Tucker's new theory does not affect the issue directly.

Marine Larval Phase

During the cruise of the "Dana" in the western Indian Ocean, mid-December 1929 to mid-January 1930, *Anguilla* larvae were collected in the Mozambique Channel, and between the northern tip of Madagascar and the coast of East Africa. These have been described by Jespersen (18) as larvae of *A. marmorata*, *A. mossambica* and *A. bicolor bicolor*. (See fig. 25.) From investigations carried out in the eastern Indian Ocean Jespersen concluded that the pelagic life of *A. marmorata* and *A. bicolor bicolor* was a short one, and that several spawning places in the Indo-Pacific Ocean were involved.

Metamorphosis, Leptocephalus into Elver

Jespersen (18) also described one metamorphosing stage and one glass eel from the Mozambique Channel taken on the 10th January, 1930 and identified as *A. mossambica*. At the same time Jespersen drew attention to how much more advanced these larvae of *A. mossambica* were in comparison with larvae of *A. marmorata*, taken just prior to this off the northern tip of Madagascar.

Skead's observations of upstream migrating eels at the wall of the Laing Dam, King William's Town, started in the summer months of 1955 and since that date scientific records have been consistently maintained (19), (20), (21), (22), (23), (24). Material collected during these observations was generously presented to this Department. Although collected within 25 miles by river from the sea, the discrepancy in size between these young eels, which had the characteristics of migrating elvers, and the true elvers of *A. mossambica*, 46 mm. to 56 mm. in length, recorded by Ege (3) from Madagascar, became apparent. (See fig. 12.) As the bulk of the Laing Dam material proved to be one species, *A. mossambica*, a search was made in the rivers of the Eastern Cape for young eels of comparable size. Skead extended his own observations to the wall of the East London Municipal Pumping Station on the Buffalo River, a short distance above the ebb and flow of the tidal section. Here the smallest specimen collected was 89 mm.

The first record of an elver of *A. mossambica* from a river in South Africa is that of Barnard (25). No date is given for the collection of this specimen, S.A.M. 18487, of 49 mm. with 103 myomeres, and which came from the Uvongo River. Further evidence came from Natal when in 1957 three specimens of *A. mossambica*, 51 mm. to 55 mm., came from the Provincial Fish Hatchery on the Umgeni River, approximately 40 miles from the sea. That same year, therefore, a tour was made of the Natal coast and much publicity given to this investigation. The result was that Mr. E. Drower, Warden of the Oribi Gorge Nature Reserve, discovered that Mr. T. Larkin, an annual visitor to Uvongo, had witnessed a migration of baby eels up the Uvongo River waterfalls early in January 1957. The site was visited and found to be ideal in that the Uvongo River waterfalls emptied into a rock-bound tidal estuary barely 150 yards from the sea. The co-operation of these two gentlemen was enlisted and during the first week in January 1958 and again in January 1959 migrations of elvers were intercepted and considerable material collected. These elvers can be regarded as not having spent any

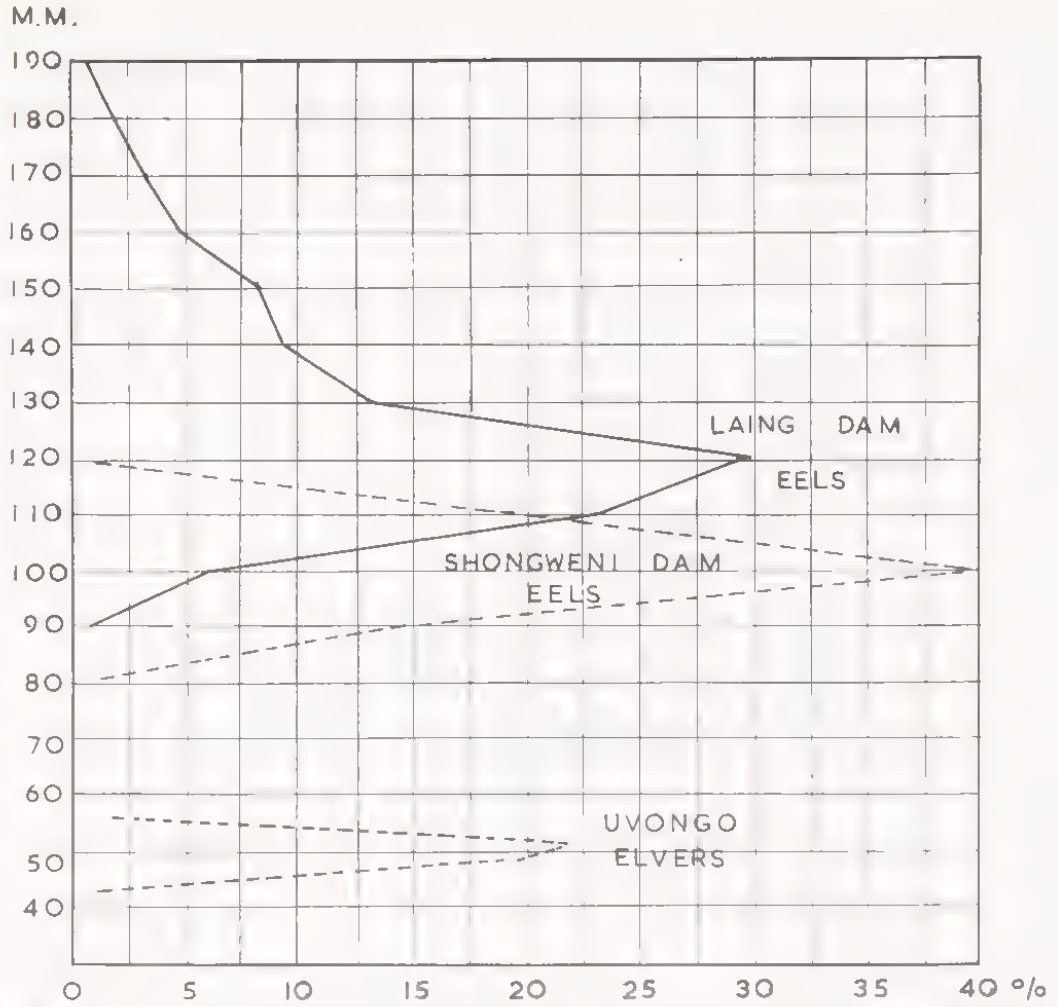


Fig. 12 Percentage frequency of length of elvers of *A. mossambica* from Uvongo River mouth, and post-elvers from Laing Dam and Shongweni Dam

time in fresh water, and as having come straight from the sea.

A characteristic of the young migrating eels from Laing Dam is their lack of pigment, in fact, on Strubberg's (26) specification they could be regarded as elvers in the last stages of metamorphosis. This lack of pigment is also consistent with the possibility that these eels had been at sea in relatively cold water for a long period (26), and they will be referred to as post-elvers.

The Uvongo specimens are, however, true elvers and the 1958 material could be divided into two groups:—

(*a*) those quite opaque, 45 mm. to 54 mm. in length, with a girth of 2.0 to 2.5 mm. and an average wet weight of 0.120 gram;

(*b*) those which were mostly transparent threads, 43 mm. to 53 mm. in length and an average weight of 0.105 gram; the average weight of 5 emaciated specimens was as low as 0.074 gram.

In the more transparent elvers the cranial pigment stood out clearly (fig. 13), as did the vertebrae, liver and stomach contents. Superficial pigment along the dorsal surface, combined with subcutaneous pigment along the vertebral column, give these otherwise transparent elvers a dark appearance. In many the stomachs contained larval shrimps whose salmon pink exoskeletons and black eyes showed through the distended stomach walls and skin quite clearly. Dr. K. H. Barnard very kindly identified specimens of these as larvae of the freshwater shrimp, *Caradina nilotica*. In some of the transparent elvers remnants of the larval teeth could still be seen under a microscope. The 1959 material was preserved in alcohol and could not be fitted to Strubberg's classification with any certainty, but both emaciated and plump elvers were present. In size range there is good agreement with Ege's record (3) of elvers of *A. mossambica* from Madagascar. Of the 551 specimens from Uvongo, none could be identified as being of any other species but *A. mossambica*. Another 16 specimens from the river above the Uvongo waterfalls were received from the Natal Museum, these were collected during the 1959 migration. The 1957, 1958 and 1959 migrations at Uvongo took place during the high spring tides, two with a new moon and one with a full moon.

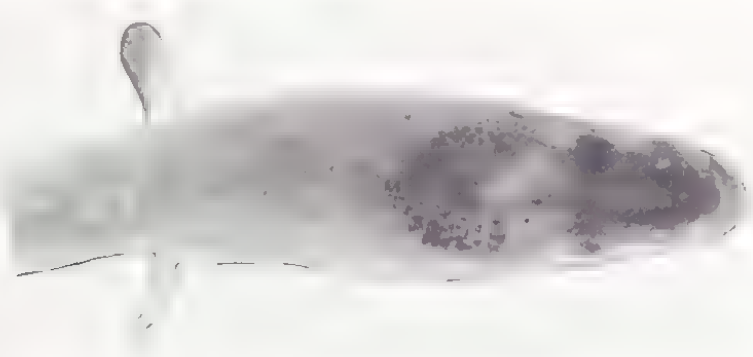


Fig. 13. Head of an elver of *A. mossambica* X 10 showing cranium pigment

Field work in Natal on the Umzimkulwana and Umlaas Rivers showed that young eels, of 70 mm. to 75 mm. in length, could be found 15 to 20 miles by river from the sea during the months August and September. These sizes were consistent with elvers of *A. mossambica* having entered these rivers during the past summer months. A complete search was made in the Kariega, Sundays and Kromme Rivers, all with mouths open to the sea, for young eels relative in size to those found in Natal, but none was found. Using the same collecting methods no small eels were found in the rivers around George, a tributary of the Kafferkuils River, the Duivenhoek, Breede and Palmiet Rivers. A visit was also paid to the famous tame eels of Platbos, Stilbaai, at the mouth of the Kafferkuils River (39). Here, since 1814, the de Jager family have fed eels which live in a never-failing fountain practically at the back door of the old Homestead. This fountain issues from under an outcrop of limestone filling a small shallow pool, and then flows into the tidal section of the Kafferkuils River 400 yards away, barely the same distance from the sea. The eels live underground and come out for food. A large *A. mossambica* of about 100 cm. came out into the bright sunlight for a crab which was dangled in the pool. Mrs. de Jager explained that the large eels disappear after many years, and that about nine eels were in the fountain ranging in size down to approximately 20.0 cm. She could not recall ever having seen anything smaller, nor could the oldest surviving member of the family.

South African Museum Specimen No. 19851, which is a pigmented and plump elver of *A. mossambica*, 51 mm. in length and which came from Malagas near the ebb and flow of the Breede River, stands unique and important as the only specimen of *A. mossambica*, or any other species of freshwater eel, from the south Cape coast less than 92 mm. in length.

In mid-February 1959, Mr. M. H. Byrne of the Durban Waterworks, Shongweni Dam, Umlaas River, supplied evidence of mass migrations by pigmented baby eels smaller than the post-elvers reaching the Laing Dam wall. These migrations have been known for some many years (27) but Mr. Byrne could not remember ever having seen, stranded or migrating, any young eels as small as the Uvongo elvers. The differences in sizes between the Laing Dam post-elvers, the Shongweni Dam pigmented baby eels and the Uvongo elvers is clearly shown in fig. 12. These secondary migrations, which take place during February and March, even whilst the spillway is floodlit (27), are probably due to population pressure caused by the elvers coming in from the sea, and occupying the lower section of the river. This second migration, the following season, could explain the migrations observed at the Laing Dam wall, but, in spite of careful and routine observations by Skead and this Department on the Buffalo, Kowie and Kariega Rivers, all open to the sea, no eels less than 89 mm. have been found.

Supported by other specimens relative in size, the following is a list of the smallest eels collected or examined, with an approximate distance of the site by river from the sea:

Breede River, Malagas, 15 miles, S.A.M. 19851	51 mm.
Homtini River, Knysna, 20 miles	159 mm.
Kromme River, Churchill Dam, 18 miles	97 mm.
Van Staadens River, 6 miles	166 mm.
Swartkops River, Bulk Dam, 25 miles	140 mm.
Sundays River, Addo, 15 miles	92 mm.
Sundays River, Lake Mentz, 65 miles	112 mm.
Bushmans River, Eastern Cape, 26 miles	98 mm.
Kariega River, Howiesons Poort, 26 miles	126 mm.
Buffalo River, Pumping Station, ½ mile	89 mm.
Buffalo River, Laing Dam, 25 miles	99 mm.
Kei River, Kabusie, 75 miles	138 mm.
Uvongo River, Uvongo Falls, ¼ mile, elver	43 mm.
Umzimkulwana River, Oribi, 15 miles	75 mm.
Umlaas River, Shongweni Dam, 20 miles	70 mm.
Umgeni Hatchery, Umgeni River, 35 miles	51 mm.
Lundi River, Southern Rhodesia, 190 miles	72 mm.
Lundi River, Gwenora Dam, 475 miles	87 mm.

All the above were identified as *A. mossambica*. Of the other species no elvers were discovered and the smallest specimens were:

Knysna River, ebb and flow, *A. bicolor bicolor*	121 mm.
Kromme River, Churchill Dam, 18 miles, *A. nebulosa labiata*	176 mm.
Buffalo River, Laing Dam, 25 miles, *A. marmorata*	174 mm.
Lundi River, Southern Rhodesia, 190 miles, *A. bicolor bicolor*	149 mm.
Lundi River, Southern Rhodesia, 190 miles, *A. nebulosa labiata*	90 mm.

Frost (14) was the first to describe elvers of *A. nebulosa labiata*, specimens of 54.0 and 58 mm., from the Mzinga River near Dar-es-Salaam, as well as elvers of *A. bicolor bicolor* from the same site. These latter elvers were 50.0 to 61.5 mm. in length, and all were collected during the period late January to mid-February 1956. Whitehead (28) reports specimens of *A. nebulosa labiata* 104.0 to 161.0 mm., taken in the Tana River during April 1958 at a site 350 miles by river from the sea. These could have been elvers of the 1957 migrations.

From the discussion above it is evident that, in the case of *A. mossambica*, metamorphosis takes place off the east coast of Africa between 21° S. and 31° S., and elvers reach the river mouths falling within this zone. Those post-elvers reaching the Buffalo River and other rivers of the south-east and south Cape coast do so by carrying out a secondary migration. From their length these post-elvers are a year to a year and a half older than the elvers, and even more in the case of larger specimens. Migrations of elvers take place in South Africa and Madagascar during the period January to March with maximum activity during January and February. The migrations of post-elvers at the Laing Dam wall, as recorded by Skead (24), take place during the period January to April.

Phase of Growth in Fresh Water. The Yellow Eel

Distribution Over a River System

The two predominant eels found in southern Africa are *A. nebulosa labiata* and *A. mossambica* (fig. 14). The inland distribution of these eels is of considerable interest as it points to a critical size at which the eel either loses its desire to migrate inland or is not capable of negotiating an obstruction.

Dealing first with *A. nebulosa labiata*, Frost (10) found three species of eels in the easterly flowing rivers of Kenya, *A. nebulosa labiata*, *A. mossambica* and *A. bicolor bicolor*, and of these the former was the only species found in the rivers above 3,000 feet, and the trout streams of the highlands. Van Someren and Whitehead (28) confirmed this in a later paper. In the trout waters of the Inyanga Mountains, Southern Rhodesia, and above broken waterfalls totalling nearly 1,000 feet, Turnbull-Kemp (12) has found just one species *A. nebulosa labiata*. Field work carried out in this same area in 1958 resulted in the same species being found in the Gairezi River, Zambezi River system, and the Pungwe River. From Northern Rhodesia Frost (9) has reported *A. nebulosa labiata* from above the Lusemfwa Falls. These falls, which total 200 feet, are on the Lusemfwa River which belongs to the Zambezi system, and approximately 630 miles by river from the sea. The Shire River, the only outlet to Lake Nyasa, flows down waterfalls and cataracts for a distance of 30 miles and a drop of 1,000 feet before joining the Lower Shire and finally the Zambezi River. This cataract section of the Shire River has isolated the fish fauna of Lake Nyasa from that of the Zambezi River for a long period in the geological history of the lake, a period of time sufficient for the evolution of 185 endemic species, but it has not stopped *A. nebulosa labiata* from entering the lake (11), (43).

South of the Pungwe River which rises in the Inyanga highlands, we find the Sabi River which is fed by the Lundi River, both systems rising on the Southern Rhodesia plateau at an altitude of between 4,600 and 5,000 feet. Field work at the headwaters of the Lundi River at 4,600 feet and 475 miles from the sea, revealed the presence of one species of eel, *A. mossambica*. As rotenone was used extensively in this area for collecting it is unlikely that other species would have escaped detection. In the Umshandige Dam on a tributary of the Tokwe River, also of the Lundi system, *A. mossambica* was the only species collected. However, below the 80-foot high spillway, which is approximately 37.5 miles from the sea, out of a total of 47 eels taken by rotenone, seven were large *A. nebulosa labiata* and the rest *A. mossambica*. In the Limpopo River system, *A. mossambica* was found to be the only species from the highveld, but *A. nebulosa labiata* was common in the lowveld section of the Nuanetsi River. In the Transvaal specimens of eels from the trout streams of the Haenertzberg have all been *A. mossambica*, whereas specimens from Marble Hall and the lowveld have been both this species and *A. nebulosa labiata*. Through Natal southwards the predominant eel throughout the system is *A. mossambica* with occasional *A. nebulosa labiata* found in the lower reaches and near the sea.

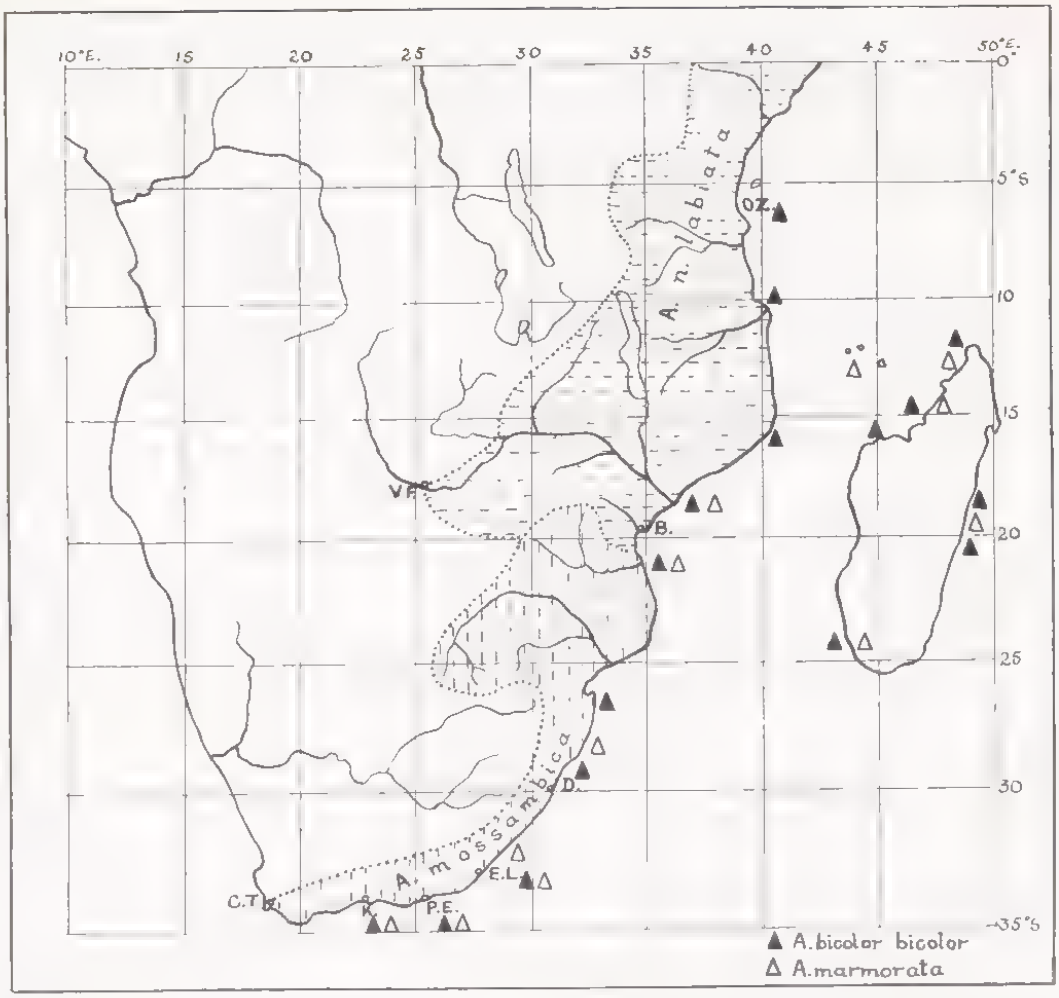


Fig. 14. Distribution of the four species of freshwater eels found in Southern Africa. The predominant eels are *Anguilla mossambica* in the south and *A. nebulosa labiata* in the north—each of these extends into the other's territory. (C.T. Cape Town, K. Knysna, P.E. Port Elizabeth, E.L. East London, D. Durban, B. Beira, Z. Zanzibar, V.F. Victoria Falls)
By Courtesy of *Piscator*

From a study of water temperatures and habitats it is quite clear that these do not govern the distribution of *A. nebulosa labiata* and *A. mossambica* over a river system. The elver zone of *A. mossambica* has been defined above as lying between Lat. 21 S. and Lat. 31 S., and by comparing this with the known distribution inland of *A. mossambica* it becomes apparent that the governing factor is the size of the eel reaching the river mouths lying within this zone. It is quite clear that this principle is applicable to the distribution of *A. nebulosa labiata* in the rivers of Kenya, and can, in fact, be extended southwards to the Zambezi and Pungwe Rivers. An elver zone for *A. nebulosa labiata* can be defined therefore as lying between the equator and 21 S. These elver zones are the areas along the east coast where all available

evidence points to the arrival of true elvers of the species *A. nebulosa labiata* and *A. mossambica.*

Frost (14) also described elvers of *A. bicolor bicolor* from Dar-es-Salaam. The southerly limit of the elver zone of *A. bicolor bicolor* is not known, but it is significant that specimens of *A. bicolor bicolor*, as small as 149 mm., were collected in the Lundi River, Southern Rhodesia, at a site 190 miles by river from the sea, an unusual distance inland for this littoral species to be found.

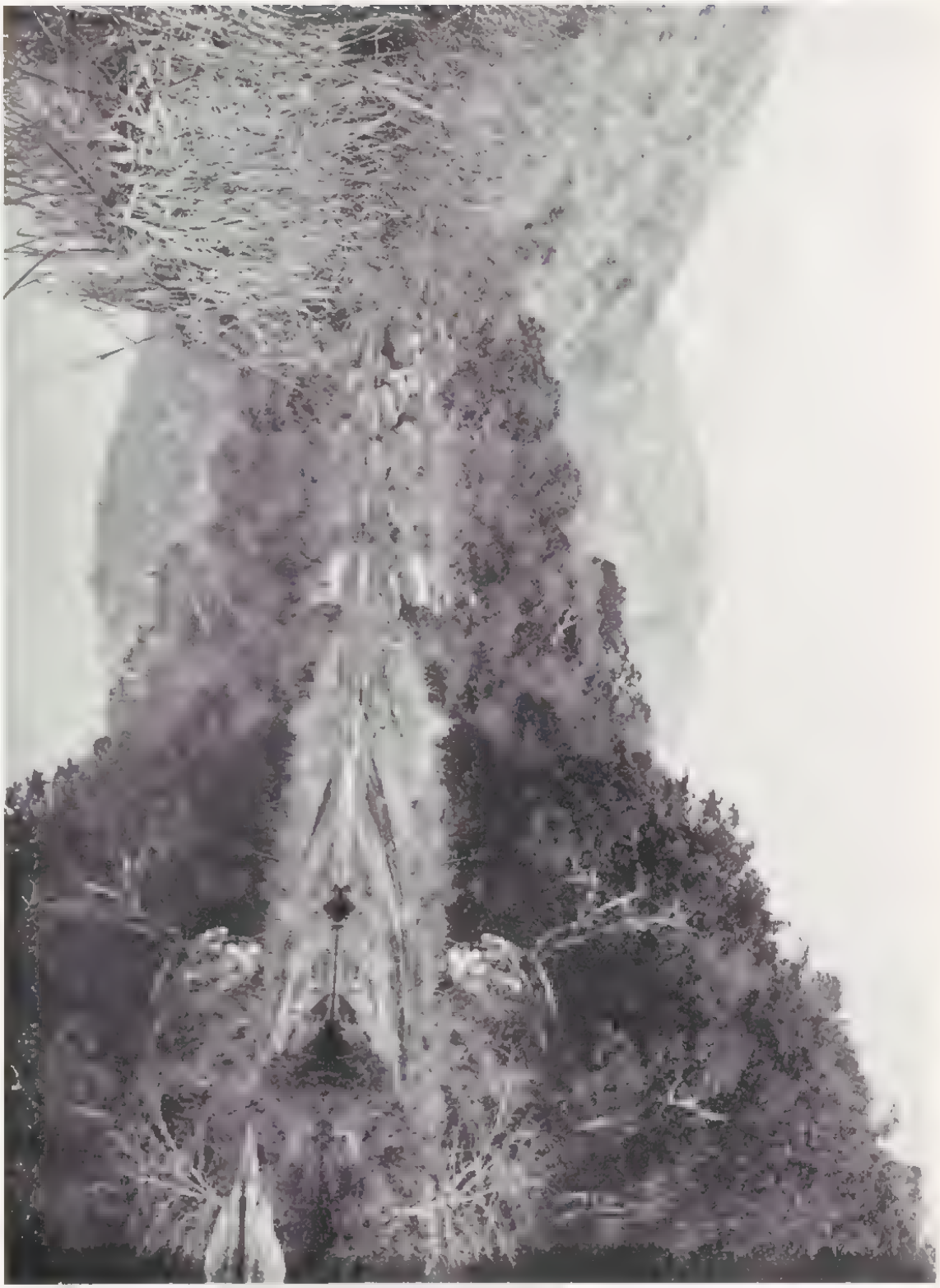
No elvers of *A. marmorata* have been discovered along the east African coast so far: the only records come from Madagascar. In South Africa this species has been found in the deep pools of the lower reaches of rivers only, and in many cases anglers take large specimens at the ebb and flow of the tidal sections of these rivers. It is only north of the Limpopo River that this species is found any distance inland. In Southern Rhodesia *A. marmorata* were taken at a site on a tributary of the Lundi River 250 miles inland. Frost (9) reports one eel, undoubtedly *A. marmorata*, from above the Lusemfwa Falls, 630 miles from the sea. Ege (3) quotes Herre as giving one of the localities for *A. marmorata* as the mountain streams up to altitudes of more than 1,530 metres (5,000 ft.), whereas Bertin (15) states: "*A. marmorata* and *A. megastoma* are on the contrary eels with long dorsal fins and speckled dress which harmonises with the pebbly bottom of inland waters; rivers of the plains for the first, mountain torrents for the second." It would appear that even *A. marmorata* can tolerate a wide variety of habitats, and that its distribution inland is also related to the size of the eel reaching the river mouth. The mouth of the Zambezi River falls within the zone from which Jespersen (18) described larvae of this species.

In studying the distribution of eels over a river system two more factors governing the ultimate dispersal over a system have become evident: the permanency of river flow, and the nature of an obstruction in relation to the distance by river from the sea.

When Livingstone discovered Lake Nyasa in 1859 the Shire River was flowing, and it can be assumed that a reasonable discharge was taking place from this sole outlet of the lake. It is not known when the water actually stopped leaving the lake, but certainly there was no flow in 1914 when the lake level reached an absolute minimum. From that date the water level gradually rose and it was not until 1934 that the flow from the lake was re-established, and a maximum level recorded in 1940. During this period mature eels must have left the lake or perished in the attempt, and as no small eels were able to enter the eel disappeared from the fish fauna of the lake. That *A. nebulosa labiata* was found in Lake Nyasa prior to 1925 is recorded by Ege (3) and Schmidt (43). It was not until 1954 that *A. nebulosa labiata* (11) was again recorded from Lake Nyasa.

Further inland, approximately 600 miles, Frost (9) records *A. nebulosa labiata* together with *A. marmorata* from above the Lusemfwa Falls, approximately 630 miles upstream from the mouth of the Zambezi River. The same distance from the sea we find the Kafue River Gorge with its waterfalls, and here no eels have been able to negotiate them. Further inland still, 900 miles from the Indian Ocean, the Victoria Falls, with a height varying from 200 feet at the western end to 323 feet at the eastern end, have proved an impassable barrier to eels and they are absent from the huge catchment of the Upper Zambezi River. *A. nebulosa labiata* is found in the gorge below the Victoria Falls and tributaries of the Zambezi River as far as 1,100 miles from the Indian Ocean. Neither the Victoria Falls nor the waterfalls of the Kafue Gorge are more formidable in height than the Howick Falls, Tsitsa Falls or Tina Falls which have been mounted by *A. mossambica* in South Africa. It would appear therefore that by the time young eels reach the Kafue Gorge they are too large to negotiate these particular waterfalls, and that physical conditions are quite unsuitable for an overland route.

That the waterfalls of the Kafue Gorge should be an insurmountable barrier to the up-



View of the Umzimkulwana River, Oribi Gorge.

stream migration of eels is of considerable interest. Only a short distance above the confluence of the Kafue and Zambezi Rivers, and set in similar physical surroundings, we find the mighty 420-foot concrete wall of the world's largest man-made lake, Lake Kariba. With a catchment area of some 56,000 square miles below the Victoria Falls, the population of eels above the wall must be considerable. Should the wall of Lake Kariba prove impossible for young eels to negotiate, as well it may, then the species *Anguilla* will disappear from the Zambezi River system above it.

Skead's (24) detailed observations of eels mounting obstructions, whilst migrating up the Buffalo River, show that most eels between 10.0 and 20.0 cm. in length have little difficulty in mounting a spillway such as that of the Laing Dam, which is 108 feet high, provided there is water coming over the spillway. Droughts and the lack of a permanent flow of water in a river have a great influence on the distribution of eels in a particular river system. The Van Ryneveldt's Pass Dam just north of Graaff-Reinet, which has frequently been dry of recent years, has not overflowed since 1933. Eels are now entirely absent from the Sundays River in this area, but old residents can remember when they were caught near the town. North of George the Doring River, which is a tributary of the Gourits River, was found flowing strongly in September, 1958. A selected section was treated with rotenone and found to be populated with *Barbus asper* only, no *Anguilla* were found. The caretaker of the Kammanassie Dam, also on the Gourits River system, said that in the eighteen years he had been there he had not heard of an eel being caught in the dam. In both cases the lack of flow of water in the Olifants River and Gourits River below had decimated the eel populations of that part of the river system. The same story holds for the Grassridge Dam and Lake Arthur on the Fish River system. Once an eel population is wiped out by drought it takes many years before sizeable eels become apparent to the angler.

As stated above, all available evidence points to the fact that the distribution over a river system is related to the size of the eel entering the river mouth. Occasional eels have been found in the Orange-Vaal river system (13) and those examined have been *A. mossambica*. Although the mouth of the Orange River is within the range of stray *Anguilla* passing round the Cape coast, it is considered that eels reaching this point and migrating up the Orange River would be too large to negotiate the Aughrabies Falls. These waterfalls are 480 feet in height and physical conditions in the area are quite unsuitable for any overland migration. On the other hand in the Heidelberg-Bethal-Ermelo area of the Transvaal highveld the tributaries of the Vaal River lie close to the headwaters of tributaries of three large systems, the Limpopo, Komati and Pongolo Rivers, all of which enter the Indian Ocean within a known elver zone of *A. mossambica*. We can therefore expect this species to make the deepest penetration up these rivers, and occasional small eels to cross the low-graded watershed during the rainy season and reach the Vaal system.

Length-Weight Curves for *A. marmorata*, *A. nebulosa labiata* and *A. mossambica*

Including data published by Frost (10) for *A. nebulosa labiata*, a length-weight diagram (fig. 15) has been prepared from material collected for the species *A. marmorata*, *A. nebulosa labiata* and *A. mossambica*. The number of specimens of *A. marmorata* is limited but throughout their range in size they have been found to be heavier than the other two long-finned eels. The curve for *A. mossambica* shows a distinct rise above 100 cm., this is due to the fact that all the specimens greater than 100 cm. in length were mature females with enlarged gonads. From Frost's (41) work a curve for *A. anguilla* would fall between those of *A. mossambica* and *A. nebulosa labiata*, and the average range in length would be less than that of *A. mossambica*. *A. nebulosa labiata* grows to a considerable length and weight, and unidentified eels whose weights have been stated to be between 40 and 50 lb. would almost certainly have been *A. marmorata* or *A. nebulosa labiata*. Schmidt (43) records a giant specimen of *A. nebulosa labiata* from Lake Nyasa whose head alone weighed 2¼ lb.

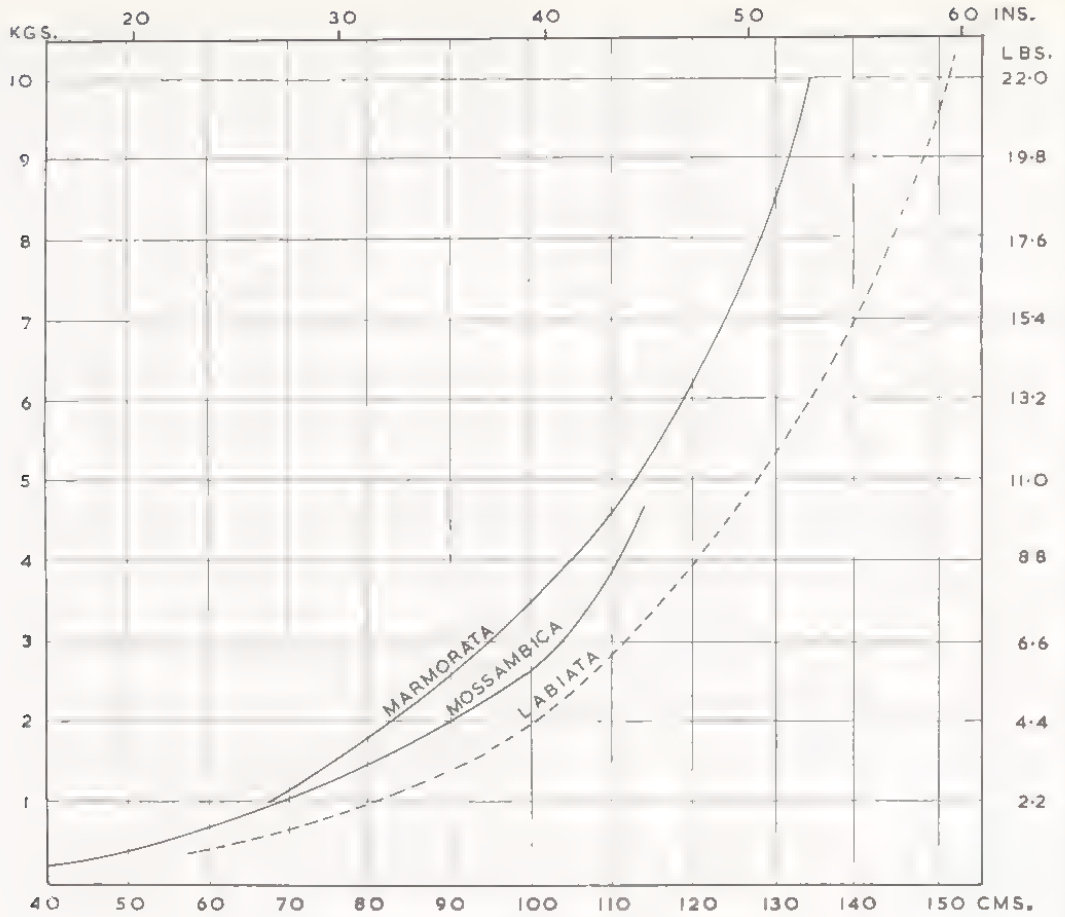


Fig. 15. Length-weight curve for the three long-finned eels.

Period Spent in Fresh Water

Working on fresh material from the eel fisheries on Lake Windermere and the River Bann, Frost (35), (40), by reading the otoliths, was able to establish that the males of *A. anguilla* stayed in fresh water 6 to 10 years, and the females 9 to 19 years. Although no mature eels of the species *A. nebulosa labiata* were found in Kenya waters, Frost (10) found that males of this species had been in fresh water 6 to 8 years, and females of 100 cm. to 128 cm. 10 to 19 years. Unfortunately otoliths removed from specimens preserved in formalin have been found to be quite unsuitable for reading. To use Frost's technique it will be necessary to remove the otoliths from freshly killed specimens, thoroughly clean them in absolute alcohol and preserve them in a normal saline solution to which a little lysol has been added. When further material has been examined it will most likely be found that *A. mossambica* follows the general trend shown by examination of the otoliths of *A. anguilla* and *A. nebulosa labiata*, and that the males stay in fresh water 6 to 10 years before reaching maturity, and the females 10 to 19 years. On length alone, the 135 cm. female *A. nebulosa labiata* from the Marble Hall Research Station in the Transvaal would have been approximately 17 years

in fresh water, as compared with *A. nebulosa labiata* of a similar length from Kenya waters.

From his work on larval eels collected in the Indian Ocean Jespersen (18) came to the conclusion that the larvae of the inter-tropical eels have a much shorter pelagic life than the larvae of *A. anguilla*; whereas the larvae of the latter species have an extended larval life of nearly three years, those of inter-tropical eels take less than a year to reach the metamorphosing stage. This naturally has some effect on the characteristics of the otoliths and has been illustrated by Frost for *A. nebulosa labiata* (fig. 16). Working on the otoliths of

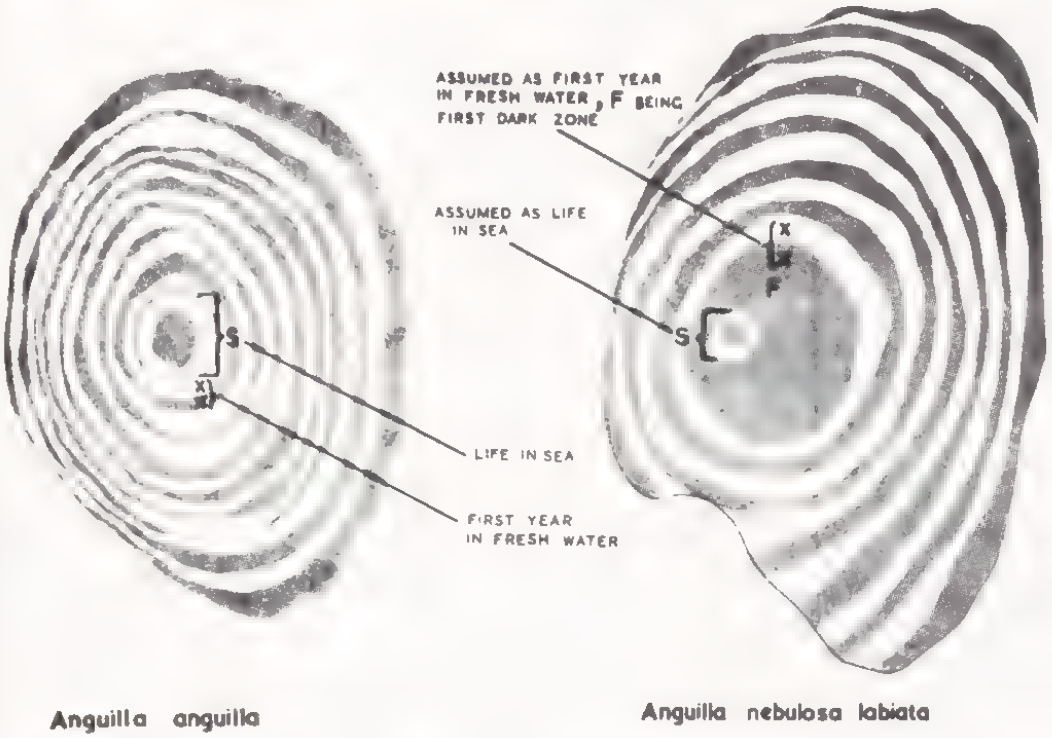


Fig. 16. *After Frost*

elvers of *A. mossambica* from the mouth of the Uvongo River both Frost and Talbot have found these to have a minute opaque nucleus surrounded by a translucent zone with a narrow opaque peripheral ring. As these elvers were taken as they were leaving the sea this must represent the life at sea, and is slightly less than the area "S" assumed by Frost to represent the life at sea spent by larval *A. nebulosa labiata*. The otoliths of post-elvers from the Laing Dam wall were found to have the opaque nucleus, translucent zone, distinct opaque band, and then a wide peripheral translucent zone similar in detail to the zones marked "S" and "F" in fig. 16 for *A. nebulosa labiata*. As the life-history of the Laing Dam post-elvers is still being studied it is not possible, at present, to say whether or not the wide peripheral translucent zone was laid down during a secondary migration at sea, or in fresh water.

Population Tests and Feeding Habits of the Eels

Where conditions made it possible rotenone powder was used for population tests. Although the results of these are valueless for the determination of the productivity of a

large river or inland water, their composition is of interest and the general trend applicable. The percentage frequency of lengths of eels collected in two tests, carried out on the Kariega and Kromme Rivers respectively, is shown in fig. 17. This trend is evident throughout the Eastern Cape, Natal and Rhodesia, i.e. a few large eels in a likely pool, together with an increasing number of small eels. In the two cases graphed in fig. 17 the drop in percentage frequency at the 40 to 50 cm. range is associated with the number of male eels found in these areas. The entire populations were *A. mossambica*.

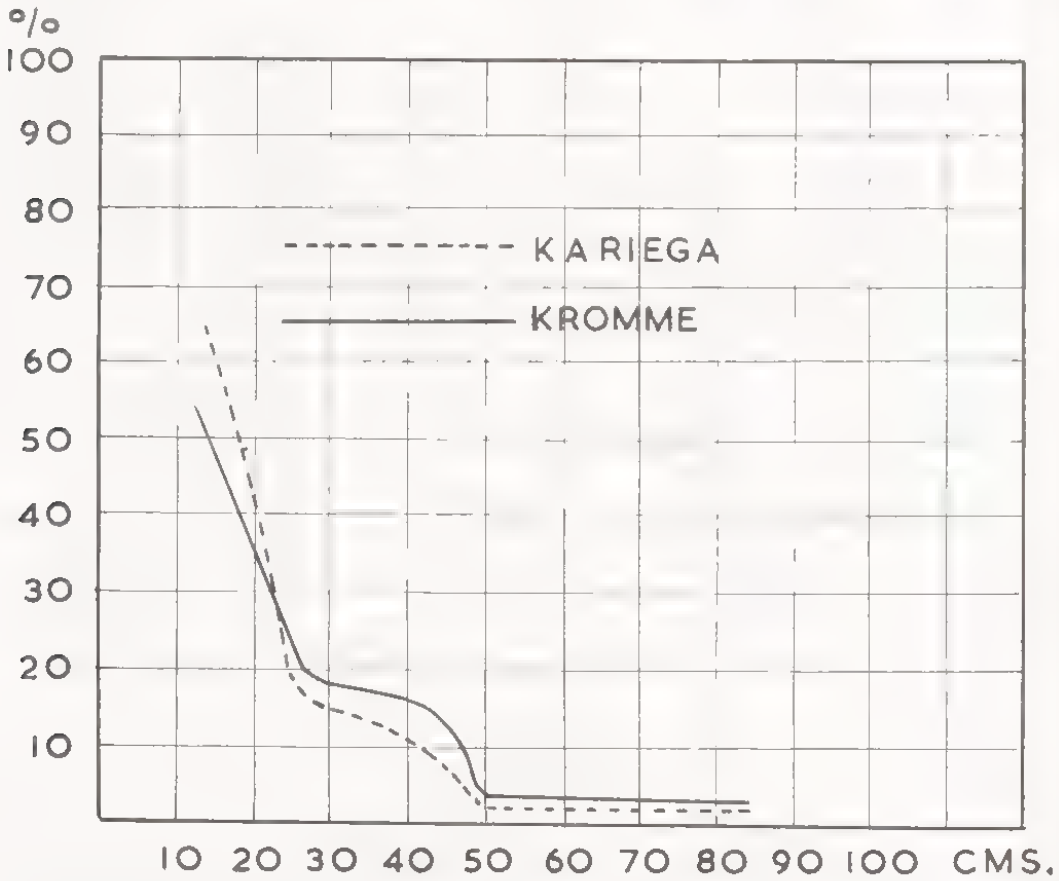


Fig. 17. Population tests made from random pools in flowing river. Percentage frequency of size. Kariega 93 specimens, Kromme 125.

Throughout this investigation the eels collected have been dissected and their stomach contents examined. A histogram (fig. 18) has been prepared from this data which covers post-elvers, feeding eels and mature eels of all species. The histogram, arranged in groups with lengths of 10 to 20 cm., 20 to 30 cm., etc., shows a marked change in diet after attaining a size of about 20 cm. From about 50 cm. onwards the aquatic larvae and nymphs of insects virtually disappear from the stomach contents and the main diet becomes small fish, crabs and an occasional frog. The larger the eel, the larger the animal preyed upon. Apart from preying upon trout, the eel, throughout its life in fresh water, is a competitor for food in trout streams. Many small eels have been found engorged with *Simulium* larvae. It is interesting

to compare fig. 17 and fig. 18 and realise how well the available food supply in an individual pool is made use of by the eels populating it. The large eels always have food, even if they have to resort to cannibalism.

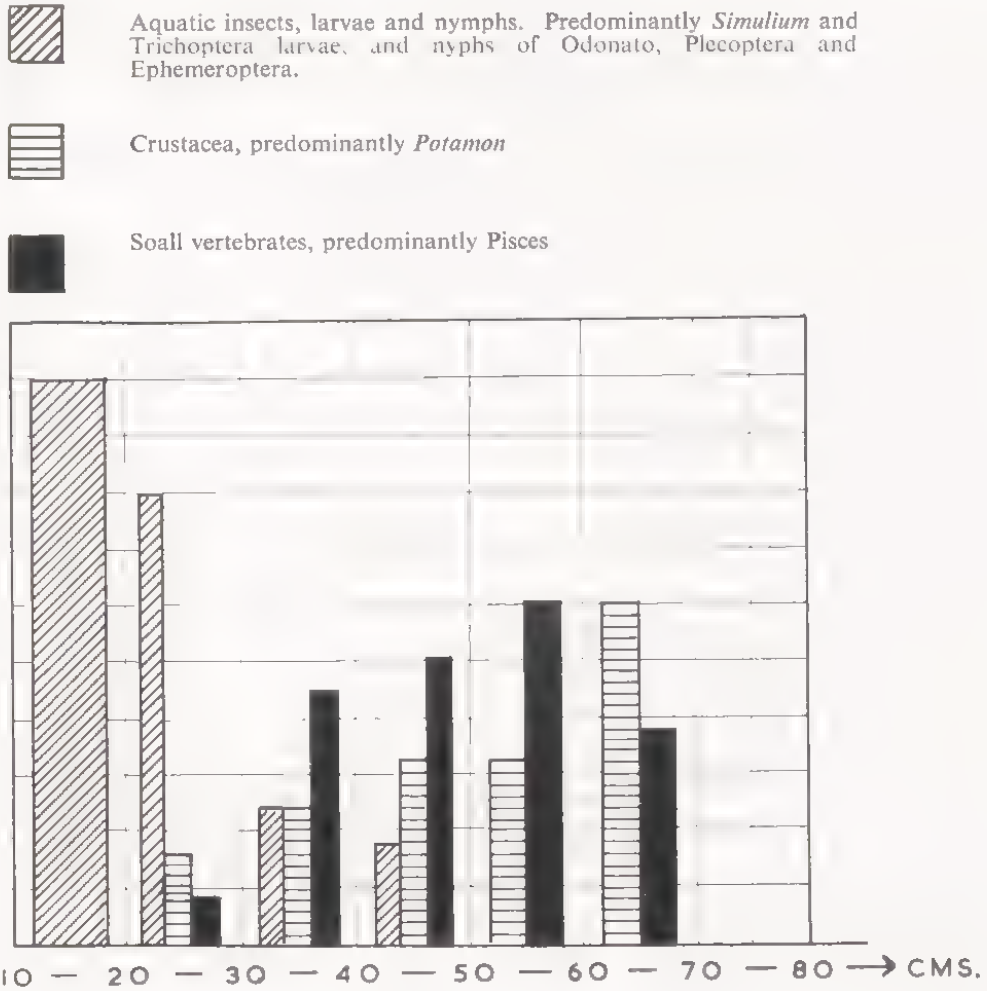


Fig. 18. Histogram showing size of *Anguilla* and percentage frequency of stomach contents

Parasites

Macroscopic examination revealed three species of internal parasites, all Nematode worms. By far the most common were those found in the stomachs of *A. mossambica*, fig. 19, from the Buffalo River. Samples of these sent to the British Museum were very kindly identified by Mr. W. G. Inglis as *Ortleppina longissima* (Ortlepp), 1922. Nothing is known of the life-cycle of this Nematode worm, but as it appears in the stomachs of eels less than 20 cm. in length, it would appear that an intermediate host could be the aquatic nymph or larvae of an insect. Although eels from the Buffalo River and the Kei River were infested those of

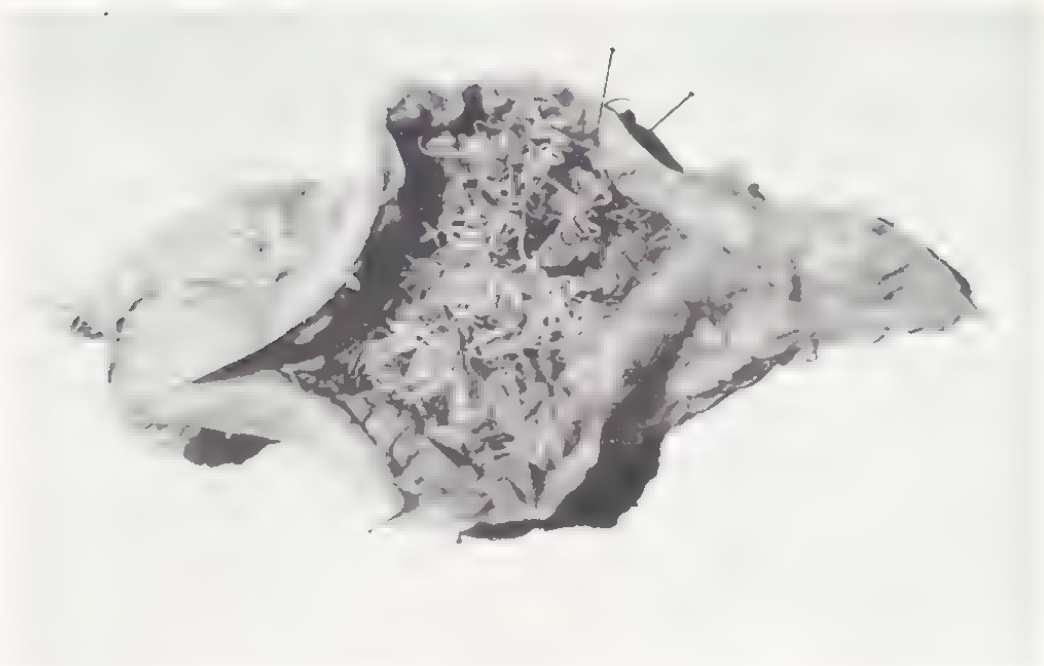


Fig. 19. Stomach of *A. mossambica* from the Buffalo River, E. Cape, showing nematode parasites.

the Kariega River and rivers round the coast to Knysna have been free of this particular parasite. Of the eels collected in Southern Rhodesia none was infected.

Second Metamorphosis: Yellow Eel to Silver Eel

The first mature eels to be recorded in South Africa were those collected by Professor Omer-Cooper of Rhodes University. On the night of 1st February 1953, eels were found crawling over the sandbar at the mouth of the Kleinemonde River towards the sea. Four specimens were collected; two of these 44.0 cm. and 43.2 cm. total length, were sent to the British Museum (10), one of 45.0 cm. to the Department of Ichthyology, and a specimen of 42.0 cm. to the South African Museum (29). All these proved to be male *A. mossambica* with well-developed gonads. The enlarged eyes and pointed snouts were typical of silver males of *A. anguilla*. The South African Museum has two more specimens, S.A.M. 12128 from the Transvaal, and S.A.M. 13423 from Zululand, Natal. The Kaffrarian Museum submitted a specimen of 47.0 cm. taken from the Laing Dam, December 1956. In the field a specimen of 43.5 cm. was taken from the Kariega River, November 1957, and 9 specimens 34.5 cm. to 51.5 cm. were taken from the Kromme River during the same month. Particular note was taken of the colour of these specimens: the dorsal surface was very dark bronze, the flanks shaded to iridescent light bronze, and the belly was silvery white. Collected at the same time were males which were obviously undergoing metamorphosis. These were slightly lighter in colour, more like the yellow eels, but the marked difference was the enlarged eye and pointed snout. The mature male *A. mossambica* from the Kromme River, with their enlarged eyes, pointed snout and well-developed gonads, dark dorsal surface and silvery white belly, were typical silver male *A. mossambica* when compared with descriptions of silver male *A. anguilla*, but all had been feeding and there was no sign of degeneration of

the gut. On the 14th March, 1959, Mr. P. McGahey found eels trying to leave the Kleinemonde River mouth and he collected a silver male *A. mossambica* of 43.0 cm. Mature male *mossambica* of 34.5 cm. to 51.5 cm. in length, and a range of 110 grams to 300 grams in weight, have been found during the months November to March.

The first mature female of this species came from Mrs. L. Jolly of Kasouga (30), where it was captured on the 16th November, 1957, as it was leaving the estuary for the sea. When alive, the dorsal surface was metallic black with iridescent sheen; the dorsal, caudal and posterior half of the anal and pectoral fins were the same colour. On the flanks the dorsal colouring blended through sea-green and sky-blue iridescent shades to silvery white belly with pale pink iridescence, rather like mother-of-pearl.

This eel weighed 3 lb. 2 oz., and had a total length of 77.5 cm. and a girth of 20 cm. When laid out flat the gonads had a maximum width of 3.9 cm. These were full of minute blood vessels giving them a general pinkish colour in contrast to the very white opaque gonads of large females approaching maturity. The egg-cells were at a stage where they were as large as 0.25 mm. in diameter, with a nucleus of 0.076 mm. In catadromous eels of the species *A. japonica*, Matsui (31) found the egg-cells to vary from 0.17 mm. to 0.27 mm. in diameter, and the nucleus diameter to vary from 0.056 mm. to 0.084 mm.

Additional material covering the period mid-October to mid-March was obtained; the largest female was 114.0 cm., weighed 10 lb. 4 oz. and had gonads 5.0 cm. wide. In all 14 of these the gonads were streaked with minute blood vessels. Of particular interest were two mature female *A. mossambica* found by Mr. Uys, caretaker of the Laing Dam, at the base of the spillway. These eels were apparently involved in a downstream migration to the sea and came over the spillway on the dry side, and were killed on the rocks 108 feet below. These eels, of 103.0 cm. and 6 lb. in weight, were found on the 16th of March, 1959, two days after an attempt by mature eels to leave the Kleinemonde River was observed by Mr. P. McGahey.

Mass migrations of mature eels on a scale witnessed in western Europe have not been observed in South Africa, but that these take place in Natal is shown by the fact that during November the 30-inch main from the Shongweni Dam, which supplies Durban with some of its water, is occasionally blocked by migrating eels and they have to be cut out in chunks (27) Of those mature female eels found during November to March, the body colours resemble greatly the published descriptions of silver female *A. anguilla* (15), and silver female *A. japonica* (31). Of the material examined the size of the silver female *A. mossambica* ranges from 77.5 cm. to 114.0 cm. and a weight of 1.1 Kg. to 4.65 K (3 lb. 2 oz. to 10 lb. 4 oz.). Silver female *A. mossambica* from this limited material are larger than silver female *A. anguilla* and *A. japonica* but the males of all three species fall within the same range. The largest male *A. mossambica* collected was 51.5 cm. and the smallest female 77.5 cm.; therefore in silver *A. mossambica* all those smaller than 55.0 cm. are most likely to be males, and all those greater than 70.0 cm. females.

One of the outward distinguishing features of the eel approaching maturity, or undergoing metamorphosis, is the enlargement of the eye, the diameter of which may be as much as doubled. Carlisle and Denton have studied the metamorphosis of the visual pigments of *A. anguilla* (32) and found that when *A. anguilla* assumes the silver livery of approaching maturity, the eye enlarges and the retina changes from a purple colour to a golden colour, like that of the chrysopsins of deep-sea fish. This change takes place even before the fish leaves fresh water. The larger eye, and relatively even larger pupil of the silver eel make it a more efficient light-collecting organ, whilst the total retinal density of photosensitive pigment is higher in the silver eel than in the yellow eel, and the retina will therefore be more efficient in usefully absorbing the light incident on it. Field notes made of the live colours of *A. mossambica*, both yellow and silver eels, show that the retina pigments respectively are the

same as those of *A. anguilla*, and, as stated above, the enlargement of the eye takes place in fresh water. The heads of a typical silver male *A. mossambica*, and silver female, are shown in figs. 20 and 22.

On the 25th of February, 1958, a mature female *A. marmorata* was collected in the Sundays River near Addo, approximately 18 miles above the ebb and flow. This eel weighed 22 lb., the total length was 134.0 cm. and the gonad width 5.1 cm. The pointed snout and gonad development can be seen in figs. 24 and 25. In colour this was also a silver eel, the dorsal surface being uniformly dark, and the belly silvery white with iridescent mother-of-pearl tints. The characteristic mottled pattern of this species was evident along the flanks. The pointed pectorals shaded from jet black posteriorly, through dark purple to silvery white. The retina of the eye was golden, but the change in retina pigment is not as marked in this species as the retina of the yellow eel tends to be olive, the predominating light colour of both *A. marmorata* and *A. nebulosa labiata*.

A large silver female *A. nebulosa labiata* was trapped in a fish pond at the Marble Hall Research Station of the Transvaal Provincial Fisheries Department, and was forwarded for

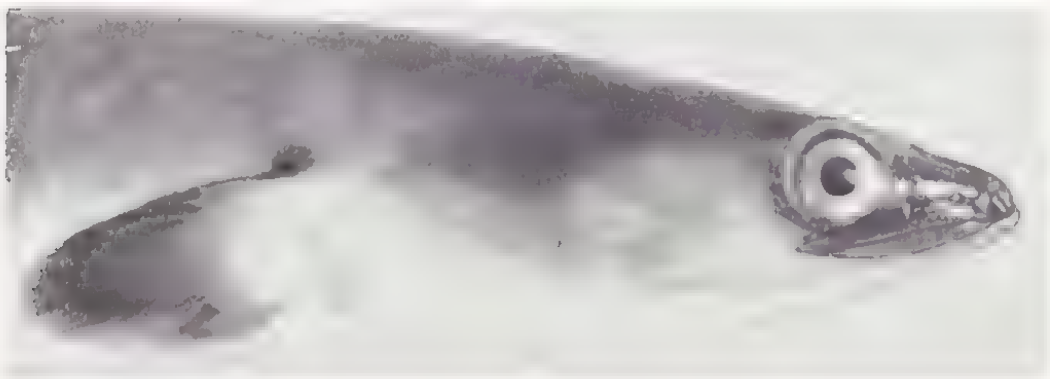


Fig. 20. Head of male silver eel, *A. mossambica*, 51.5 cm. (about 20 inches) from Kromme River, November, 1957. Note pointed snout and large eye.
(*Photos:* R. A. Jubb)

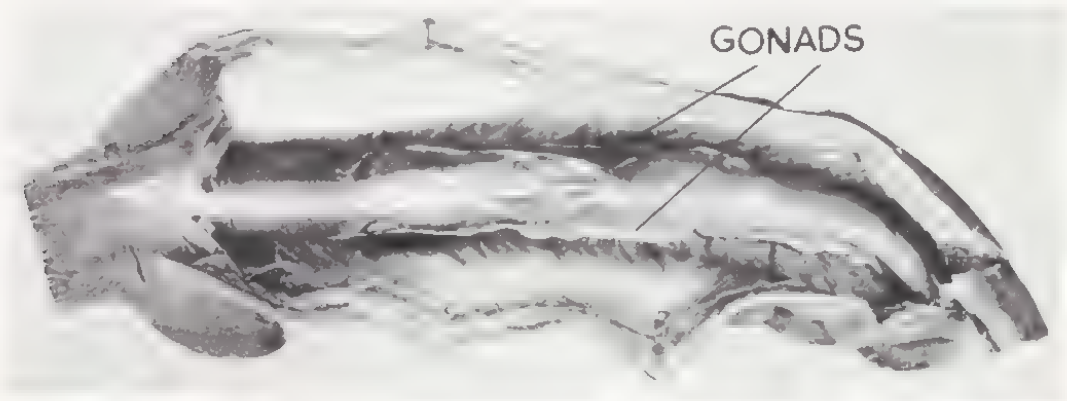


Fig. 21. Gonads of male silver *A. mossambica*

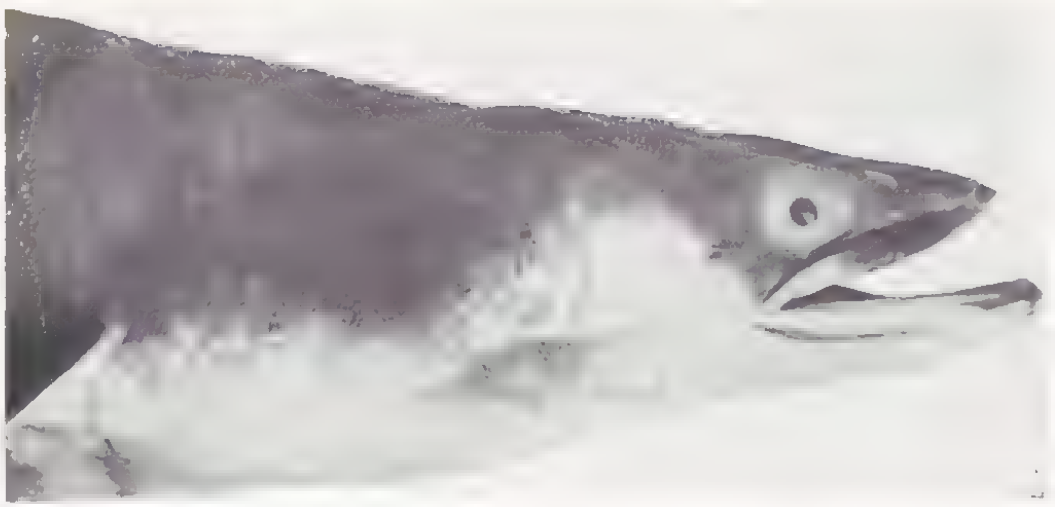


Fig. 22 (*Photo:* R. A. Jubb)
The head of female silver eel *Anguilla mossambica*, length 40 inches, weight 6 lb. This shows the large eye and pointed snout. This specimen was one of some which unwittingly committed suicide in trying to go downstream from the Laing Dam on the Buffalo River. They went over the spillway and crashed onto the rocks below, where they were found by Mr. P. F. Uys, Supervisor of the dam, in March 1959

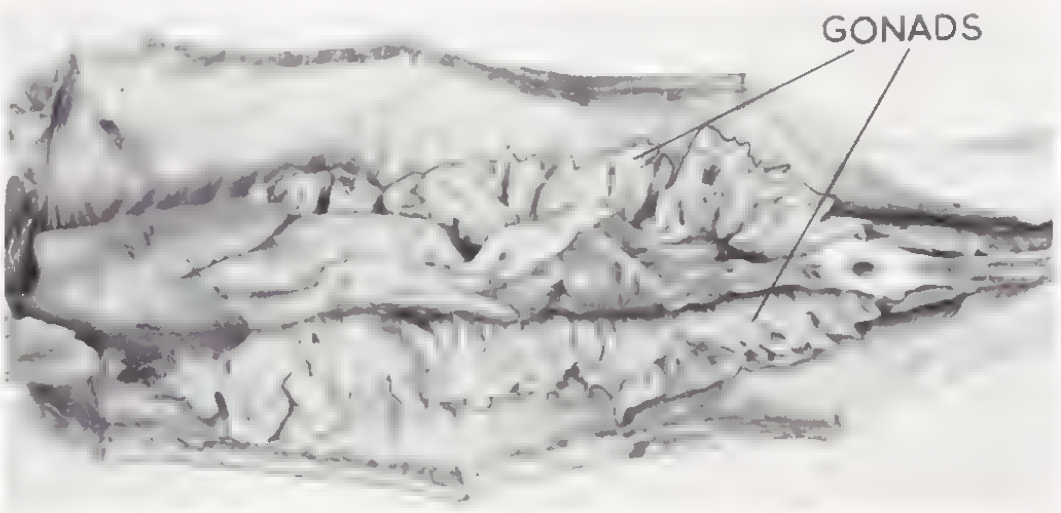


Fig. 23. Gonads of the Kasouga River silver female eel. The gonads extend well posterior of the anus.

examination. The large eyes, pointed snout and pectoral fins, together with enlarged gonads, showed this to be a mature female. This specimen had a total length of 135.0 cm. and weighed 16 lb. The site where this eel was captured is approximately 375 miles from the Indian Ocean. A male *A. nebulosa labiata* of 59.0 cm. was collected by R. Boltt near Chirundu, Zambezi River, in September 1959. This eel, with its enlarged eyes and gonads, and the pointed

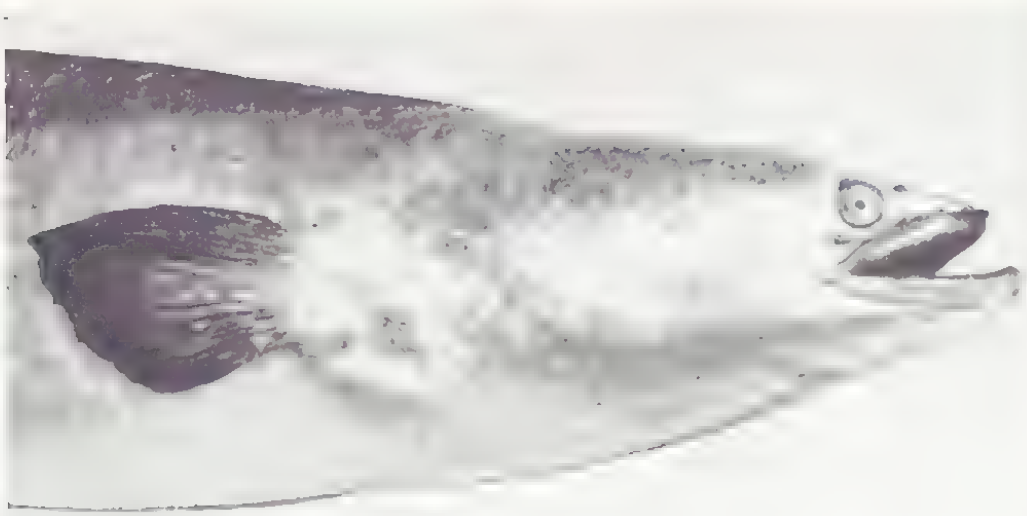


Fig. 24. Head of a large mottled eel *Anguilla marmorata* from the Sundays River. Note large eye and pointed snout of the mature female.

(*Photo:* R. A. Jubb)

Fig. 25. *Gonads of silver A. marmorata*

snout of the mature eel, was probably preparing to migrate downstream with the seasonal floods of December and January. As this site is 600 miles from the sea, it is of great interest to realise just how far inland this final metamorphosis starts. Neither of the above two speci-

mens was seen alive, but the preserved specimens are very dark on the dorsal surface, with light belly and mottled pattern on flanks.

During ploughing operations in a swamp near the Umfolozi River, Zululand, in September 1957, Mr. L van Heerden captured a female *A. bicolor bicolor* of 64.0 cm. and 1 lb. 2 oz. in weight. The width of the gonads was 1.2 cm., the eyes enlarged and the snout pointed. In contrast to the usual olive colour the dorsal surface was uniform bronze and the belly silvery. Like all the other specimens of mature *Anguilla* found in South African rivers, this eel was still feeding.

From material collected and received for examination it is evident that eels in South African rivers undergo metamorphosis from the yellow eel to the silver eel during the period September to December, and that mature silver eels can be found during the months November to March. In this regard it should be noted that catadromous eels are common in England and Ireland during the months October to December, in Italy October to December, and Japan September to January. If, as is generally accepted, the mature eel requires rivers in flood to facilitate its journey to the sea, then along the coast from the Zambezi River to East London we can expect maximum activity during the rain months January to March.

Hypothetical Breeding Grounds of the Eels whose Elvers reach South Africa

Of the five species of eels of which adults have been found, the elvers of three, *A. nebulosa labiata*, *A. mossambica* and *A. bicolor bicolor* are known to reach the East Coast of Africa. The elvers of a fourth species, *A. marmorata*, are known from Madagascar and larval eels from the vicinity of Madagascar and the East Coast of Africa have been described by Jespersen (18). Thus four distinct species, either as elvers or as larval eels, can be found along, or adjacent to, the east coast during the same seasonal period. By their very nature the leptocephalids of these species would be carried towards Madagascar and Africa by the South Equatorial Current. This, as is shown in fig. 26, is split by the island of Madagascar, part going round the northern tip and part going round the southern tip. The flow round the northern tip splits again, part curling northwards and becoming the East African Coastal Current (33), and part curling southwards through the Madagascar Channel where it is known as the Mozambique Current whose warm water sweeps the coast of Portuguese East Africa and Natal. The flow round the southern tip of Madagascar curls slightly north-west before joining the Mozambique Current and flowing south-west as the Agulhas Current. This combined current of warm water flows southwards along the coast of Natal and Pondoland, but south of Port St. Johns the picture becomes complex. Counter-currents of relatively colder water are found close inshore, and the warm Agulhas Current continues southwards as an off-shore current until it reaches the Agulhas Bank. According to Clowes (34) this obstruction causes a deflection to the south-west of the greater part of the Agulhas Current, but a further obstruction is encountered in the presence of the eastward-flowing water of the South Atlantic Ocean. This causes the main part of the Agulhas Current to be bent back on itself and flow towards the east, being now known as the return Agulhas Current. Although the main part of the Agulhas Current is deflected as stated, and eventually returns eastwards to the South Indian Ocean, it is also a fact that a small part of the current flows both over and round the Agulhas Bank.

The current flows in fig. 26, which has been extended to fit the known distribution of elvers and larval eels, give a broad picture of prevailing conditions during January and February. As it is during these months that cold in-shore counter-currents are common along the south-east coast, these have been marked in. Jespersen (18) has shown that a likely breeding place for *Anguilla* species in the Western Indian Ocean could be found east of Madagascar between 10 S. and 20 S., and between 60 E and 65 E. Assume that *A. mossambica* used the southerly portion of this hypothetical breeding area. The bulk of the larvae would then be carried on the southern periphery of the South Equatorial Current, and larvae

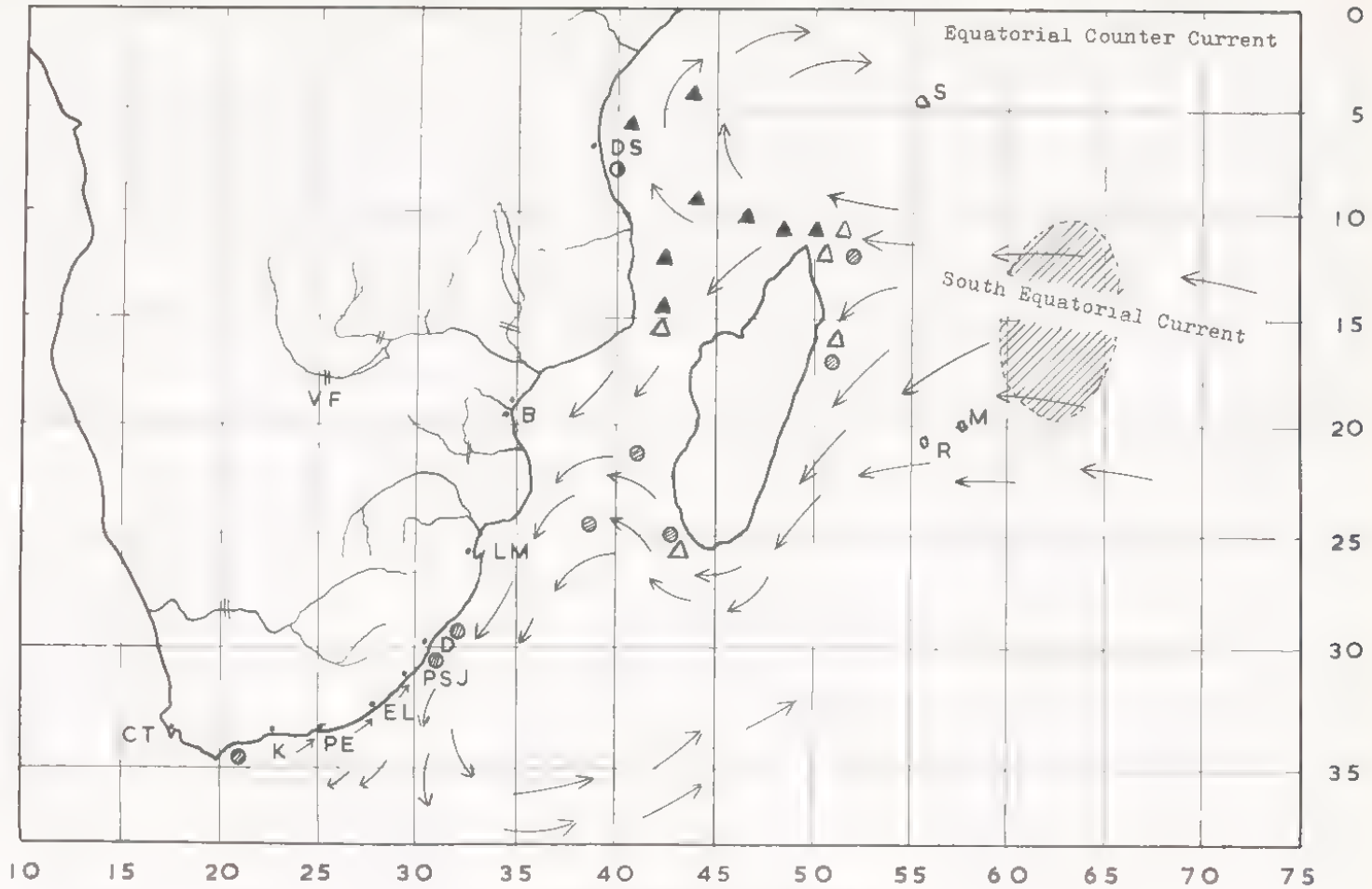


Fig. 26. Prevailing ocean currents with distribution of elvers and larval eels during the period December to February. Hatched area hypothetical breeding ground

△ *A. marmorata*

◑ *A. nebulosa labiata*

▨ *A. mossambica*

▲ *A. bicolor bicolor*

‖ ***Significant waterfalls or cataracts***

and elvers would reach the east and south-west coasts of Madagascar, as well as the coast of Portuguese East Africa south of Lat. 21 S., and Natal. With the prevailing Agulhas Current swinging away from the coast south of Port St. Johns, and due to marked phototaxis and thermotaxis (15), current-carried larvae would tend to align themselves with the warm water and be carried past the south-east coast towards the Agulhas Bank. Here, according to prevailing conditions, some pass westwards, but the majority swing eastwards in the return Agulhas Current. In both cases it is considered that metamorphosis is completed.

Strubberg (26) has shown that metamorphosis is accelerated by high water temperatures and retarded by low temperatures. The Breede River specimen of *A. mossambica*, S.A.M. 19851, of 51.0 mm., is proof that some larval eels are carried westwards, and its size may be associated with ambient water temperature. Just what happens to those post-elvers carried into the South Indian Ocean is pure conjecture, but it is thought that these remain at sea feeding and growing until they reach a size at which they are capable of stemming the current and reaching the mainland. It is probable that these are the post-elvers that reach the rivers of the south and south-east coasts, between Knysna and the Kei River mouth, and populate them. Like their adults, tendencies towards thermotaxis disappear once metamorphosis is completed.

From the known elver zones and distribution of larvae, it seems likely that the northern section of this hypothetical breeding ground is used by *A. marmorata*, *A. nebulosa labiata* and *A. bicolor bicolor*, and the bulk of the larvae carried in the northern periphery of the South Equatorial Current into the East African Coastal Current and the northern part of the Mozambique Current. If this hypothesis is correct then it is difficult to understand why *A. nebulosa labiata* is absent from the rivers of Madagascar. If future collections of eels from Madagascar show that this is indeed the case, then *A. nebulosa labiata* either breeds close to the coast of East Africa, or its larval life is a prolonged one. In this latter case, as propounded by Tucker (16), larval environment may account for the mean vertebral count of 111 which separates this species from *A. nebulosa nebulosa* which has a mean vertebral count of 109, and they may actually originate from the same spawning area.

Therefore, as suggested by Jespersen (18), a breeding ground east of Madagascar for the species *A. marmorata*, *A. mossambica* and *A. bicolor bicolor* is highly probable. Not only does such a site favour the dispersal of larvae in the South Equatorial Current, but also it is within reasonable distance of Madagascar and the East Coast of Africa for mature eels to return for breeding purposes. As stated before, there is evidence of considerable wandering around in the sea by post-elvers after metamorphosis, and this could account for the specimen of *A. obscura* found in the Buffalo River, near King William's Town.

Exploitation of Fresh Water Eels

The prevailing price in Cape Town of smoked eels imported from Holland is R1.45 a pound. Danish eel cutlets, in small tins, sell at R0.62 a tin, and in Pretoria Japanese processed eels can be bought for R0.48 a tin whose contents weigh 3½ oz. From advertisements in the Press offering special eel dishes there certainly appears to be a demand for smoked or processed eel flesh. In addition to this there is a big demand for flesh of high protein value, which in the case of the eel ranks with that of fowl flesh and is slightly higher than that of beef. In South Africa, where there are eels in the rivers, it has been found that there are ardent eel anglers of all races who fish for eels for their own consumption; in conversation all those anglers who have been interviewed declare that eel flesh is a delicacy.

In Europe eel fisheries operate by intercepting the catadromous mature eels as they leave large inland waters for the sea. One of the largest commercial eel fisheries operates on the River Bann, which empties Lough Neagh, a lake of 153 sq. miles in Northern Ireland. Another extensive eel fishery operates at the mouth of the 125 sq. mile Commacchio lagoon

in Northern Italy. It is these large inland waters with their single outlets that provide the most economical way of cropping the eel populations. This is done by a system of weirs and traps right across the river. The effects of floods are cushioned by these expanses of water. To ensure that eel populations are maintained, elvers migrating annually from the sea are intercepted in simple but efficient traps (35) and transported to the inland waters. From both Ireland and England elvers are exported annually to Holland and Germany for stocking rivers and dykes.

In South Africa there are no inland waters comparable in size with those of western Europe. It is only in the larger and more permanent rivers flowing into the Indian Ocean that we can expect to find eel populations that can be continuously exploited. But due to floods, which usually carry the mature eels to the sea, permanent eel weirs would be a problem. Large dams assist, not only in providing living space for eels, but also in cushioning the effects of floods, and it is at the exits of these that eels could be trapped. The proviso is, of course, that the dam is of a fairly permanent nature, and elvers can reach it. Dam walls near the sea provide an excellent site for trapping elvers or post-elvers for stocking inland waters, and the Laing Dam wall on the Buffalo River is such a site. Experiments have been carried out which show that post-elvers can be transported by organised transport from this site to any major river system in the Cape Province, Orange Free State and Natal.

The largest river system in the Union is the Vaal-Orange which very few eels reach. Some of the rivers of the Transkei and Natal, with their deep meandering channels near the sea, provide large volumes of water which harbour hordes of eels. The Bashee River has long been famous for its eels and it is north of this that the first and only eel fishery in South Africa operated.

In 1949 Mr. G. Hylton-Gardiner (36), after preliminary investigations, decided to establish a commercial eel fishery in the Humansdorp area. He brought an expert eel trapper, Mr. B. P. de Kriek, from Holland and operated on the Kromme and Gamtoos Rivers. An eel smokery was established at Humansdorp, and as the product compared very favourably with that imported from Holland he was able to dispose of all that could be produced. These two rivers did not contain eel populations sufficient to stand exploitation and supplies diminished. Knowing the Transkei rivers Gardiner moved to Umtata in early 1950. In this area eels proved to be plentiful and again he had no difficulty in disposing of the processed catch commercially in East London. Unfortunately Gardiner died in May 1950, and with him the initiative for this venture, as well as a scheme he wished to organise for harvesting eels in the Transkeian rivers, from which Natives would benefit financially as collectors.

For the catching of large eels de Kriek used Dutch "fuik" nets and baited hand-lines, the latter proving more efficient. During this investigation it has been found that night lines, baited with fresh *Barbus* or *Labeo*, were more efficient for catching eels than "fuik" nets or baited eel traps of wire-netting as used in New Zealand (37). Electrical methods, which have proved efficient in New Zealand (38), have not been used. Where eels can be cropped in mass migrations properly constructed weirs of nets and traps would be the most economical and efficient way of cropping eels, but in South African rivers this is not feasible except in the vicinity of large storage dams. The more large inland waters there are, the greater will become the possibility of cropping eels efficiently in rivers where they are numerous. There are no stocking problems to contend with as each year the sea provides millions of healthy young eels which could support a large industry if they had water in which to feed and grow.

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I am indebted to Professor J. L. B. Smith of the Department of Ichthyology for proposing this interesting investigation, and to the Council for Scientific and Industrial Research, Pretoria, for a generous grant which enabled me to carry out field work covering the rivers of South Africa from the Cape to Southern Rhodesia.

A more opportune time to initiate this project could not have been chosen as much interest in the freshwater eels had been stimulated by the writings of Mr. A. C. Harrison, Editor of *Piscator*, the Journal of the Cape Piscatorial Society. As will be seen in the list of references Mr. Harrison has shown a keen interest in this work, and he has very kindly loaned some half-tone blocks for illustrating this paper.

In 1948 Dr. Winifred Frost of the Freshwater Biological Association, England, an authority on the European eel, spent six months in Kenya studying the biology of the eels of Kenya rivers. I have been fortunate in having at my disposal her published works and collaboration in an investigation which still has many puzzling problems to solve.

Mr. J. Skead, Director of the Kaffrarian Museum, started his observations on the migrations of eels up the Buffalo River in 1955, and he has very generously placed his data and material at my disposal, and has guided me to excellent collecting sites in his area. In their respective areas Mr. F. Talbot of the South African Museum, and Mr. R. Liversidge of the Port Elizabeth Museum have been most co-operative in providing technical assistance and material.

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Through the courtesy of the Conservator of Forests, and the Municipalities of East London, King William's Town, Port Alfred, Grahamstown, Port Elizabeth and George, I was granted access to rivers and storage dams not normally frequented by the public.

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R. C. BIGALKE, Dr. Phil. Nat.
McGREGOR MEMORIAL MUSEUM,
KIMBERLEY.

Some observations on the Ecology of the Etosha Game Park, South West Africa.

Introduction

The Etosha Game Park, also known as the Etosha Pan Game Reserve, Namutoni Game Reserve, Game Reserve No. 2, or simply as the Etosha Pan, is situated in the northern part of South West Africa approximately between 14° and 17° E. and 18° 30′–19° 30′ S. (map 1). It is bounded by farms in the south and east and by the Ovamboland and Kaokoveld Native Reserves in the north and west respectively.

The Park was proclaimed by the German governor of the time, von Lindequist, on 22nd March, 1907, and the proclamation took effect on 1st May of that year. The country surrounding the Etosha Pan as well as the whole of the Kaokoveld became *Wildschutzgebiet Nr.* 2 and it is still officially termed Game Reserve No. 2 (*S.W.A. Gazette*, 1958*a*). The latter designation is applied to a somewhat smaller tract of country than that defined by the 1907 proclamation however, for parts of the old *Wildschutzgebiet* were excised for farming purposes as the Territory developed. Despite the official nomenclature, the Etosha Game Park, the boundaries of which were recently defined by the Game Parks and Private Game Reserves Ordinance (*S.W.A. Gazette*, 1958*b*), has been under the control of the Game Conservation Section of the S.W.A. Administration for some time. The Kaokoveld Native Reserve is administered by the Department of Native Affairs.

It is with the Etosha Game Park *sensu stricto*, an area of some 8,500 square miles, that this paper is concerned (map 1). The observations recorded here were made during the period April 1956 to March 1958 when the writer was employed by the Game Conservation Section and stationed in the Park. Most of them were included in two unpublished annual reports submitted to the Administration.

Topography and Soils

Wellington (1955) distinguishes the Kalahari Basin as one of the main physiographic regions of Southern Africa and divides it, mainly on hydrographical grounds, into three sub-regions: the Southern Kalahari, the Northern Kalahari and the Etosha Basin. Most of

the Park falls within the latter although parts of it merge into the adjoining sub-region known as the Chela-Otavi Highlands, which is characterised by Otavi dolomite with karst features.

The central feature of the Park is the Etosha Pan which has an elevation of roughly 3,500 feet above sea-level. It is 60-70 miles long, from south-west to north-east, and about 30 miles broad, with a floor of sandy clay, saline in parts, particularly along the southern edge. Wellington (loc. cit.) describes its water relations as follows: "The pan is the end-basin of the drainage coming mainly from the north, but an affluent from the east, the Omuramba Ovambo, brings a small volume of water to the pan in most years. As we have seen the pan lies in a structural basin, the Ovashimba highlands (over 5,000 feet above sea-level) of Otavi Sandstones and conglomerates bound the basin to the west, and the Otavi limestone rises gradually southwards to 4,500 feet. There is no rock surface to the east, where the basin is bounded by a sand swelling in the Omaheke sandveld about 600 feet above the pan floor. North of the pan the sandveld rises very gently towards the Ovamboland administrative centre Ondangua, the gradient being of the order of 2 feet to the mile."

The Etosha Pan is usually dry and desolate. The last time it was entirely covered with water is said to have been in 1934. However in most years the eastern part near Namutoni holds water for several months after the end of the rains. Jaeger (1926-7) also mentions this and I was able to observe it in two successive years. In 1957 shallow water (1½-2 feet) remained until July while in 1958 it dried up a few months earlier. This water is brought down by the Omuramba Ovambo which would seem to be the only drainage channel with a large and regular flow.

Because of the nature of the surface south of the pan—Otavi limestone with shallow turfy soil in places most of the rainwater soaks away and there is little drainage from that direction. From the west too only a negligible quantity of water enters the pan, probably because of the absence of channels. The Ekuma river comes from the north and enters the Etosha Pan at its north-west corner. But in normal years it does not appear to bring down much water, a fact already noticed by Jaeger (loc. cit.) who states "Ueberhaupt haben die Missionare vom Westufer aus niemals Wasser auf der Pfanne gesehen, und die Ovambo bestaetigen dies . . ." The very gentle gradient north of the pan is probably the main reason.

For the most part the Park is characterised by extreme flatness. The outliers of the Kaokoveld highlands are situated near the western boundary and a few small koppies occur on the southern border. Half-way between Okaukuejo and Namutoni and 7 miles south of the pan Tweekoppies form a prominent landmark. These isolated hills of Otavi dolomite are approximately 300 feet higher than the surrounding country. Shallow depressions in the form of meandering omurambas (dry watercourses) to the south and small pans to the west of the Etosha Pan are a feature of the landscape.

The soils of the Park can only be described in the broadest of terms as they have not yet been studied in detail. Limestone covers much of the ground surface south of the Etosha Pan and there is little soil in this region. What there is, is shallow, grey, poor in humus and powdery, becoming sticky when wet. In depressions it is deeper, black and turfy. Soil of a similar nature extends across the southern part of the western sector of the Park, i.e. from the southern boundary up to the vicinity of the 19 line of latitude. Here limestone outcrops are not so common or so extensive. Northwards the grey soil merges into grey Kalahari sand which stretches from the 19th parallel to the border of the Park and beyond into Ovamboland. Reddish to greyish white Kalahari sand is also found in the north-eastern corner from Namutoni to the northern and eastern limits of the Park.

Climate

Meteorological data are available in the form of rainfall records from Okaukuejo and Namutoni, formerly police posts and recently also tourist camps (Table 1).

TABLE 1.

Total annual rainfall (mm.) recorded at Okaukuejo and Namutoni.

Year	Okaukuejo	Namutoni	Year	Okaukuejo	Namutoni
1922	—	220·0	1940	515·6	257·9
1923	—	709·2	1941	348·8	—
1924	—	385·2	1942	604·3	—
1925	—	600·7	1943	294·9	—
1926	—	449·7	1944	595·1	—
1927	—	329·0	1945	453·4	445·6
1928	—	—	1946	184·4	90·4
1929	—	342·9	1947	523·4	416·9
1930	—	284·7	1948	302·7	552·3
1931	—	467·2	1949	424·4	281·2
1932	—	—	1950	821·7	975·4
1933	—	256·3	1951	460·8	546·9
1934	827·5	633·8	1952	292·3	304·1
1935	306·1	375·7	1953	389·6	523·9
1936	316·1	324·9	1954	676·9	696·5
1937	349·0	608·4	1955	296·4	391·9
1938	594·2	—	1956	438·1	588·5
1939	498·1	554·9	1957	478·6	546·7

— denotes no records available.

The mean annual rainfall at Okaukuejo, calculated for 24 years, is 458 mm. with a standard deviation of 162.9. That at Namutoni, computed from the records for 29 years, is 453.8 mm. with a standard deviation of 180.1. Fluctuations about the mean are thus considerable and reflect the unpredictability and irregularity of the rainfall.

In most years the rains commence in October (very rarely in September or November) and continue until April (very rarely until March or May). The precipitation in each month of the rainy season is shown in Table 2.

TABLE 2.

Mean monthly rainfall (mm.) at Okaukuejo and Namutoni, rainy season.

Month	Okaukuejo (mean of 24 years)	Namutoni (mean of 29 years)
October	13·5	16·6
November	33·5	42·6
December	92·3	76·6
January	90·1	88·7
February	115·4	99·2
March	83·1	86·1
April	27·5	26·5

The Park, like most of the Territory, is thus a summer rainfall area with almost completely dry winters.

Unfortunately temperature and humidity have not been recorded. Temperatures are high during the summer and frost occurs frequently during the winter months. The daily range of temperature is also considerable at all times of the year.

Vegetation

The vegetation of the Park is poorly known. This account is thus of necessity very broad and incomplete. It is based partly on an unpublished departmental report (Joubert, 1956) prepared by the Pasture Research Officer of the Department of Agriculture, modified by the present writer. Joubert has distinguished four main types of vegetation. These will be dealt with in turn.

Type 1. *Plains around the Etosha Pan*

This zone has very few bushes or trees and consists of a mixture of grass and low shrubs or karroid scrub. It is a sparse pioneer community with a low basal cover and grows on a powdery lime soil poor in humus. Only in the south-western extension of type 1 do we find trees and bushes.

The plains border the pan in the south, east and west, occasionally attaining a width of three or four miles. We do not yet know whether they also occur along the northern margin. From the Okaukuejo-Okondeka road this vegetation type extends for 30-40 miles to the complex of small pans west of the Etosha pan. It forms the area known as Groot Vlakte (map 1). Here scattered belts of Mopane (*Colophospermum mopane*), Slapdoring (*Acacia glandulifera*) and Gabbabos (*Catophractes alexandri*) interrupt the plains in places but the composition of the ground layer remains essentially constant.

The grasses are short and widely spaced. Common species include *Enneapogon brachystachyus*, *Aristida curvata* and in places *Eragrostis denudata*. The first two are annuals. However *E. brachystachyus* gives the impression of being a perennial because of the persistence of the old plants through the dry season. They produce basal spikelets which remain enclosed, drop to the ground and, in the following spring, germinate and grow up through the remaining basal tuft of the parent plant (Stopp, 1958). A taller perennial common near Okaukuejo is *Monelytrum luderitzianum*.

These grasses and the ephemeral forbs which spring up are heavily grazed in the Groot Vlakte area during the rainy season, when game concentrates there in large numbers. It is during the growing period that annuals have a high feeding value whereas during the dry months they contain little or no nutriment. In this respect, as is well known, they differ from perennial grasses. Walter and Volk (1954) have summarised the difference as follows: "Bei den ausdauernden Graesern (perennials) . . . wandert nur ein Teil der Naehrstoffe in die Fruechte, waehrend der andere Teil in den Halmen oder Wurzelstoecken gespeichert wird, die so auch in der 'kalten Zeit' den Weidetieren wertvolles Futter bieten koennen. Einjaehrige Graeser (annuals) sind nur im gruenen oder halb-reifen Zustand fuer die Ernaehrung der Tiere von Bedeutung, nach dem Absamen liefern sie nur noch Ballastfutter." In addition it seems likely that the annual species are more palatable in summer than are the perennials, since they lack the tough remains of the plants of the previous year from which the latter start their new growth.

In addition to the common grasses to which mention has been made, pure stands of coarse quick grass, possibly a *Cynodon* species, occur in restricted areas near the edge of the pan, as for instance in the vicinity of Okondeka.

The common small—12-18 inch high bushes of vegetation type 1 are *Leucosphaera bainesii*, *Cyathula* sp., *Petalidium* (*englerianum?*) and *Justicia* sp.. Locally, dense, pure stands of a *Salsola* sp. are encountered and in saline depressions *Suaeda* is a common halophyte.

Along the western border of the pan a leguminous shrub becomes dominant. On slightly elevated ground, small coppices of *Acacia glandulifera* (Slapdoring) about 6-8 feet high are characteristic. *Aloe rubrolutea* grows over large areas; it is a conspicuous element in the landscape along the road from Okaukuejo to Namutoni.

Type 2. Andoni flats and extensions of the Pan

The vegetation of the Andoni flats, which is the only extensive area with this type in the Park, is a very simple halophitic community of perennial grasses where bushes and trees are absent. Both the soil—grey Kalahari sand—and the plant cover are essentially the same as those of the adjoining plains of southern Ovamboland. Since Andoni is level there is little surface runoff and this presumably accounts for the high salinity which seems to control the nature of the vegetation.

Type 3. Northern perennial long-grass veld

This is savannah with the perennials *Anthephora pubescens*, *Schmidtia bulbosa*, *Heteropogon contortus* and *Aristida uniplumis* dominating the grass layer, while Mopane (*Colophospermum mopane*) in both tall and dwarf forms is the commonest tree. Patches of *Catophractes alexandri* (Gabbabos) and *Acacia glandulifera* (Slapdoring) are encountered locally, *Terminalia prunioides* (Deurmekaarbos) is a fairly common tree and the Witgatboom, *Boscia albitrunca*, occurs. In the deeper soil of depressions fine specimens of Hardekool (*Combretum imberbe*) and *Acacia* (probably *hebeclada*) are found.

Much of the Mopane attains a height of only about 4 feet and is commonly referred to as the "dwarf form". Joubert (loc. cit.) has suggested that this may be due to the prevalence of veld fires which often sweep into the Park from Ovamboland. Another possible reason is seen by Dr. Martin (personal communication) in the fact that the ground water here is usually strongly saline.

This savannah type occupies that part of the western section of the Park where Kalahari sand occurs, i.e. from the north-western corner of Etosha Pan westwards, presumably right to the western border (which I did not visit) and south to about the 19th parallel of latitude. South of this line it merges into the southern savannah.

Type 4. Southern perennial long-grass veld with Mopane

Related to the northern type this community grows on stonier, shallower soil of a different character where surface limestone outcrops are a feature. There are thus more pioneer species in the ground layer. The main grasses are *Triraphis ramosissima*, *Anthephora pubescens* and *Aristida uniplumis*; *Fingerhuthia africana* is also present, particularly on surface limestone. Local pockets of black turfy soil occur, where dense stands of tall *Aristida meridionalis* and sometimes of *Eragrostis superba* are prominent.

The Mopane is by far the commonest tree and dominates the landscape. It does grow in the "dwarf form" but is usually found as a medium-sized tree (about 15 feet) in park-like woodland or as a medium to large tree (15-25 feet) in dense groves. In places the Deurmekaarbos (*Terminalia prunioides*) and a *Combretum*, probably *apiculatum*, are numerous and sometimes co-dominant with Mopane. Gabbabos (*C. alexandri*) is fairly widespread, especially on raised ground. On deeper soils and near waterholes the Hardekool (*Combretum imberbe*) is found.

As described thus far, vegetation of type 4 occurs

(*a*) in the south-western section of the Park, south of 19° S. and west of the Groot Vlakte. Here it is rather dry and the trees tend to be smaller; dense stands of *Acacia*

detinens are encountered and Gabbabos is rather more prominent than in the other areas;

(*b*) south of the Etosha Pan to the border of the Park, excluding the area described under (*c*). This is the most typical form of the type;

(*c*) in the extreme eastern section of the Park, in the vicinity of Namutoni and for some distance south of this camp, a modified form of the southern savannah becomes dominant. The upper layer is a tall, thick woodland in which Mopane is very scarce; *Spirostachys africanus* (Tambooti), *Commiphora* spp. (Kannidood), Deurmekaarbos and Hardekool replace it. Wild figs (*Ficus* sp.) and *Acacias*, probably mostly *hebeclada*, occur, the latter sometimes alone. Large outcrops of limestone cover much of the ground surface;

(*d*) north of Namutoni another variation of type 4 extends up to the southern edge of the Andoni flats. On the deep reddish-yellow sand Appelblaar (*Lonchocarpus capassa*), *Terminalia prunioides*, *T. sericea* and *Commiphora* spp. are conspicuous trees; the widespread *Catophractes alexandri* also grows here but groves of tall *Acacia detinens* tend to replace it. The grasses are mainly perennial species.

The southern perennial long-grass veld is the most varied vegetation type in the Park and closer study may show that it requires subdivision. However it will be considered as one with the four sub-types listed above for this paper, mainly because of the uniformity of the grass layer.

Water

The location and availability of surface water in an arid area such as the Park is an ecological factor of major importance. For most of the year the animals are dependent on the permanent waterholes, natural and artifical. Consequently their distribution is decisively influenced by the position of these drinking places.

From map 1 it is apparent that the majority of the permanent waterholes are situated along the southern edge of the Etosha Pan and in the adjacent southern savannah (vegetation type 4). Some 20 large springs and numerous smaller ones are found on or near the pan margin. The water is saline in almost all cases and salt crusts are deposited around the sides. Scattered tufts of a member of the *Cyperaceae* ("biesies") grow near them. In the southern savannah we find about 18 waterholes –the number is approximate because the area has not been fully explored– and two windmills. The natural holes vary in size and in the amount of water produced. They are all permanent except perhaps in very dry years. Many are set in crater-like depressions and most are surrounded by a dense growth of reeds and other aquatic plants. In nearly all cases the water is sulphurous.

The eastern edge of the pan has 3 natural springs while according to Jaeger (loc. cit.) there is no permanent water on the northern side. Andoni, an artesian spring opened up by drilling in the course of prospecting operations some 30 years ago, is the only water available on the Andoni flats throughout the year.

The section of the Park west of the Etosha Pan is very poorly supplied with drinking places. There are 5 widely separated natural holes –Okondeka on the pan edge, Narawandu, Okakuamburu, Onaiso and Okatjongeama– and the four windmills at Okahakana, Adamax, Leobrunn and Grünewald.

During the rainy season there is more surface water than in the dry months. This is particularly the case in the otherwise poorly watered western section, where there are numerous small pans and hollows. The Natukanaoka pan and its outliers running across Groot Vlakte assume great importance in summer as we shall see in the next section.

Game Movements

As far as can be ascertained, Fischer (1914) was the first to publish a description of game migration in the area now called the Etosha Game Park. By migration I mean a regular annual shift of the bulk of a population from one area to another and back. He writes that the grazing grounds in the vicinity of the Etosha Pan were deserted, sometimes almost overnight, by zebra, gemsbok and springbok when they migrated westward after the first good rains. According to his account hartebeest and kudu did not migrate, while wildebeest moved eastward. Shortridge (1927) described the same phenomenon as follows: "That (the rainy season) is the time when a large percentage of Burchell's Zebra, Wildebeest, Hartebeest, etc., leave the permanent springs in the Namutoni Game Reserve in search of fresh grazing grounds—supplementing those (animals) that may be more or less resident in Ovamboland and elsewhere". He made further reference to the migration in a later work (Shortridge, 1934).

In this section my own observations and some quantitative data on the migration will be presented and an attempt will be made to relate it to environmental factors. The accompanying maps should be used as adjuncts to the text. Map 1 is a general one showing the rest camps, roads and larger waterholes. In map 2 the Park has been tentatively and approximately divided into several zones. Different patterns of shading distinguish the dry season concentration area (d.s.c.a.), wet season dispersal area (w.s.d.a.) and probable wet season dispersal area (p.w.s.d.a.). The Namutoni area and the Andoni flats do not appear to be referable to any of these heads and will thus be treated separately. Areas the status of which is doubtful or unknown we left blank.

Broadly speaking, the differences between the distribution of game in the dry and in the wet season may be stated as follows: During the dry season the majority of the zebra (*Equus burchelli antiquorum* H. Smith), wildebeest (*Connochaetes* (*Gorgon*) *t. taurinus* Burchell) and springbok (*Antidorcas marsupialis* Zimm.) by far the most abundant ungulates—are concentrated around the permanent waterholes east of the Outjo-Okaukuejo road. This has been designated the d.s.c.a. After the onset of the rains most of these animals migrate to grazing grounds west of the road where they are probably joined by migrants from Ovamboland. This has been called the w.s.d.a. and it is thought to include the country labelled p.w.s.d.a. Here they drop their calves, lambs and foals. Gemsbok (*Oryx g. gazella* Linn.) and giraffe (*Giraffa camelopardalis* Linn.), which are fairly evenly distributed over both d.s.c.a. and w.s.d.a. during the dry months, become scarce in the latter during the rainy season. Their movements at this time are not understood. Eland (*Taurotragus o. oryx* Pallas) also appear to change their grazing grounds but even less is known about their behaviour.

This simple statement of the position requires some qualification. From a meteorological point of view the dry season extends from May to September and the rainy season from October to April. However we cannot apply these terms absolutely to game migrations. It will be shown that a typical "dry season distribution" may persist until well after the commencement of the rainy season *sensu stricto* and that a "wet season distribution" may cease before the end of the rainy season proper.

The following comparison between the observations made during the dry seasons of 1956 and 1957 on the one hand and during the wet seasons of 1956-7 and 1957-8 on the other, will serve to illustrate the seasonal differences in distribution. The operative word is "illustrate", for the composite picture I have of the migration has been built up from innumerable small incidents and general impressions which cannot all be reproduced here.

Dry Season

(*a*) D.S.C.A.

Game counts were made at four of the waterholes in this area. The results are summarised in Table 3.

TABLE 3.

Dry Season Waterhole Counts.

Dry Season Concentration Area.

Date	Place and Period	Z	Wb	Sp	Gb	K	H	Gir	Whg
	Ombika								
17-7-56 ..	15.10-18.30	c160	—	1	—	19	—	—	7
12-11-57 ..	10.00-18.15	c165	2	c60	—	16	—	—	3
14-11-57 ..	10.15-18.20	c150	7	c95	11	7	—	2	11
	Gemsbokvlakte								
22-8-56 ..	09.45-12.30	c280	—	41	34	3	—	—	—
	Ondongab								
15-10-56 ..	10.00-17.30	111	57	31	64	—	—	11	—
7-12-56 ..	09.15-19.00	c90	61	c350	92	—	1	1	—
11-7-57 ..	10.30-18.15	64	—	45	38	—	1	—	—
15-7-57 ..	10.40-17.30	42	9	57	77	—	—	—	—
16-7-57 ..	09.50-17.50	25	9	43	82	—	1	—	—
17-7-57 ..	10.50-15.45	27	25	54	101	6	—	—	—
18-7-57 ..	10.10-17.25	44	10	43	91	6	—	—	—
19-7-57 ..	09.50-17.25	27	10	53	75	7	—	—	—
..	Kapupuhedi								
14-9-56	08.00-16.00	c100	56	12	c49	—	—	—	—
12-10-56 ..	09.30-16.25	c345	5	60	32	—	—	—	—
23-10-56 ..	09.00-16.25	c275	—	87	90	2	—	—	—
16-11-56 ..	09.15-17.25	104	44	—	61	—	—	—	—
17-7-57 ..	09.30-16.00	109	—	27	37	—	—	—	—
19-7-57 ..	09.20-17.35	c100	—	39	42	—	—	—	—

Abbreviations:

Z — zebra
Wb — wildebeest
Sp = springbok
Gb = gemsbok
K — kudu
H — hartebeest
Gir — giraffe
Whg = warthog
c = approximately

They show that zebra, wildebeest, springbok and gemsbok are the dominant species and give a rough indication of the population of a small part of the Park, perhaps 70 square miles in extent. Counts made from the road following various routes give an impression of game numbers over a wider area (Table 4).

TABLE 4

Dry Season Road Counts.
Dry Season Concentration Area.

Date	Route and Distance	Z	Wb	Sp	Gb	K	H	Ed	Gir
18-7-56	On-Kap-Ok .. .. 15m.	98	c105	c80	69	6		—	—
25-7-56	Ok-Kap-On-H-Nam rd. 30m.	c350	c450	c250	17	—	2	—	10
1-8-56	Ok-Kap-On-G .. 24m.	c530	c80	109	53		—	—	6
30-7-57	Ok-Obk-Go-Nam rd. 75m.	c400	83	c190	21	47	c40	c60	—
9-11-57	Ok-Kap-On .. .. 15m.	61	c175	20	c70	—	1	—	—
18-11-57	Ok-Kap-On-Riet .. 33m.	20	c170	257	43	—	—	—	—
18-11-57	Riet-On-Kap-Ok ..	37	c290	c130	c70	—		—	4
30-7-57	Ok-Nam* .. .. 84m.	c445	c380	c520	3	4	11	—	2
	(*a*) Ok-Kap-On-Riet	c70	c90	c370	3		11	—	—
	(*b*) Riet-Nam .. 51m.	c375	c290	c150	—	4	—	—	2

Abbreviations:

Game species as in Table 3; Ed — eland.

On = Ondongab
H = Homob
Obk = Ombika
Nam = Namutoni
Kap — Kapupuhedi
Nam rd. — Namutoni road
Go — Gobaub
Ok — Okaukuejo
G — Gunuob
Riet — Rietfontein

The same conclusion can be drawn from these results, viz. one sees more zebra, wildebeest, springbok and gemsbok than any other hoofed animals. The data collected along the Okaukuejo-Kapupuhedi-Ondongab-Homob-Namutoni road route, a distance of only 30 miles, on 25-7-56 provides a good instance of how abundant they are in some places. Giraffe are generally encountered in small parties. Eland and hartebeest (*Alcelaphus buselaphus selbornei* Lyd.) numbers appear from Table 4 to be very low. This is not a fair picture of the position for they occur in sizeable herds at several southerly waterholes which are not included in the Table because no counts were made there.

It should perhaps be noted here that road counts are of very little use in calculating population density per unit area in the Park. During the day the majority of the animals seen along the southern edge of the pan are at the waterholes. This is probably because their feeding grounds extend away from the water in only one direction, the pan being practically bare. They seem to spend the night in the southern grassveld, come to water from about 8-9 a.m. and remain nearby for the rest of the day until 4-5 p.m. Day counts thus show concentrations at the waterholes and most of the intervening country appears empty.

(*b*) W.S.D.A.

The game population here is distinctly different from that of the d.s.c.a. Counts made at waterholes and from the roads during two successive dry seasons are set out in Tables 5 and 6.

**Note:* The figures for the count along the Okaukuejo-Namutoni road do not include game seen within 8-10 miles of Namutoni. That area is dealt with separately from the d.s.c.a.

TABLE 5.

Dry Season Waterhole Counts.
Wet Season Dispersal Area.

Date	Place and Period	Z	Wb	Sp	Gb	Ed	Gir	Whg
17-10-56	Adamax wm. .. a	—	—	c85	c65	—	11	—
17-10-56	Grünewald wm. .. a	15	—	c200	90	6	—	3
8-10-57	Grünewald wm. .. a	c70	1	c150	c80	17	—	—
11-11-57	Okondeka.. .. a	—	—	c90	—	—	—	—
10-8-57	Okahakana wm. .. a	—	—	10	—	—	—	—
10-9-57	Okahakana wm. .. a	—	—	18	11	—	—	—
8-10-57	Okahakana wm. .. a	—	—	—	4	—	—	—

Abbreviations:
Game species as in Tables 3 and 4.
wm. = windmill; a = counted on arrival, no time spent watching.

TABLE 6.

Dry Season Road Counts.
Wet Season Dispersal Area.

Date	Route and Distance	Z	Wb	Sp	Gb	Ed	Gir
4-5-57	Ok-Grünewald .. 30m.	—	—	c175	c50	—	32
10-5-57	Ok-Grünewald .. 30m.	—	—	c125	115	1	—
10-10-57	Ok-Grünewald .. 30m.	c25	—	c160	c50	20	12
8-11-57	Ok-Grünewald .. 30m.	—	—	—	c35	1	7
3-10-57	Grünewald-Groot Vlakte .. .. 10m.	38	—	c195	c20	1	—
25-10-57	Okondeka-Adamax-Grünewald* .. 28m.	6	—	c150	c75	—	4
19-11-56	Ok-Okondeka .. 14m.	4	17	c500	2	—	—
18-12-56	Ok-Okondeka .. 14m.	14	16	c590	4	—	—
25-10-57	Ok-Okondeka .. 14m.	—	—	c140	11	—	—
31-10-57	Ok-Okondeka .. 14m.	—	2	c250	10	—	—
2-11-57	Ok-Okondeka .. 14m.	8	—	c480	58	—	—

Abbreviations:
Game species as in Tables 3 and 4; localities as in Table 4.
**Note:* Game at Okondeka waterhole excluded.

We see that gemsbok and springbok are the only large ungulates found in any quantity. Zebra and wildebeest, so common in the d.s.c.a., are very scarce. Furthermore, and this is not apparent from the Tables, most of the zebra occur at Grünewald windmill, which is on the border between the short-grass plains of Groot Vlakte and a strip of southern perennial-grass savannah. They graze mainly in the latter area. A small herd of eland, also at Grünewald, were the only representatives of the species seen in the w.s.d.a. in two dry seasons. Giraffe numbers seem to be at about the same level as in the d.s.c.a.

(*c*) P.W.S.D.A.

Although we do not know this area well, the indications are that its game population is similar to that of the w.s.d.a. during the dry season but smaller. In June, 1957, before the road that now runs along the 19th parallel (map 1) had been built, an exploratory cross-country journey of about 35 miles was made from Adamax westward approximately along the present course of the road. The vegetation was northern perennial-grass savannah, no surface water was found and only a few small herds of gemsbok, one of hartebeest and one of giraffe were encountered. Some fresh eland spoor was also seen.

(*d*) Areas of doubtful status.

Two other accessible parts of the western portion of the Park, falling within the areas left blank on map 2, were visited during the dry season only. The first is traversed by the Okondeka-Okotomare-Ovamboland road. Once the country served by Okondeka, which extends about 13 miles from the waterhole, is left behind, one generally finds only a few ostrich (*Struthio camelus* Linn.) and occasionally a few gemsbok. The second is that through which the Okahakana-Narawandu-Ovamboland road passes. This I saw on two occasions; only a few springbok, gemsbok and hartebeest, and once a troop of three lions (*Panthera leo* Linn.) were recorded. On the whole then, the game population is probably similar to that of the p.w.s.d.a. but perhaps even smaller.

The entire north-western sector of the Park was inaccessible at the time of this study. I did not get to the waterholes Okatjongeama, Onaiso and Okakuamburu and consequently cannot provide any information on the game there.

Wet Season

(*a*) D.S.C.A.

Unfortunately only a little data was collected in 1956-7. Game numbers were lower than in dry weather at the waterholes visited. Thus zebra drinking at Kapupuhedi over a 7-8 hour period declined from 104 on 16th November, 1956, to 23 on 20th November and 10 on 22nd November. Only 25 wildebeest and 2 springbok were seen at Gemsbokvlakte on 13th January, 1957, whereas 250-300 zebra and smaller groups of springbok and gemsbok were almost invariably to be found there in the dry months. On 27th February, 1957, only 21 zebra came to Ondongab in 4½ hours (cf. Table 3).

The results of counts made during the 1957-8 rains give a clearer picture of game numbers over a bigger area (Table 7).

TABLE 7.

Wet Season Road Counts.
Dry Season Concentration Area.

Date	Route and Distance	Z	Wb	Sp	Gb	K	H	Ed	Gir
20-12-57	Ok-Nam* .. .. 84m.	c940	c373	c458	55	9	16	—	—
	(*a*) Ok-Riet .. 33m.	c780	c350	c450	51	—	12	—	—
	(*b*) Riet-Nam .. 51m.	c160	23	8	4	9	4	—	—
18-1-58	Ok-Nam	11	c250	c295	17	4	7	—	3
	(*a*) Ok-Riet	11	c175	c295	7	—	—	—	—
	(*b*) Riet-Nam	—	c75	—	10	4	7	—	3
19-1-58	Nam-Ok	—	c290	5	16	10	21	—	13
	(*a*) Nam-Riet	—	c100	—	—	6	—	—	5
	(*b*) Riet-Ok	—	c190	5	16	4	21	—	8
14-2-58	Ok-Nam	—	c174	c112	113	—	26	—	6
	(*a*) Ok-Riet	—	c160	2	113	—	24	—	6
	(*b*) Riet-Nam	—	14	c110	—	—	2	—	—
15-2-58	Nam-Ok	—	c335	1	c75	25	10	—	—
	(*a*) Nam-Riet	—	25	1	—	24	—	—	—
	(*b*) Riet-Ok	—	c310	—	c75	1	10	—	—
7-3-58	Gemsbokvlakte-On 9m.	409	25	—	2	3	—	—	—
7-3-58	On-Ok .. .. 15m.	215	6	—	8	—	—	—	—
8-3-58	Ok-On .. .. 15m.	c715	21	—	10	—	—	—	—
9-3-58	Ok-Nam	c1,820	c295	c180	15	c52	—	4	5
	(*a*) Ok-Riet	c1,350	c130	c175	12	c15	—	4	5
	(*b*) Riet-Nam	c470	c165	5	3	37	—	—	—
9-3-58	Nam-Ok	c1,615	c130	c55	9	9	—	—	—
	(*a*) Nam-Riet	c570	c100	—	—	9	—	—	—
	(*b*) Riet-Ok	c1,045	c30	c55	9	—	—	—	—

Abbreviations:

Game species as in Tables 3 and 4; localities as in Table 4.

Excluding those counts dated December and March for a moment, it is obvious that the zebra population had slumped. The abundance of the species in December is rather striking and unexpected however. As the w.s.d.a. was already populated by migrants at this time, it is probable that those seen in the d.s.c.a. on 20th December were late-comers about to move westward. This supposition is supported by the fact that on that date many more were found between Okaukuejo and Rietfontein than in the eastern sector between Rietfontein and Namutoni. In the dry season (30-7-57, Table 4) the opposite was the case. The March counts were made at a time when migrants were returning to the d.s.c.a. and they will be dealt with below.

Turning now to other species, Table 7 shows that on the whole wildebeest and springbok

**Note:* The figures for all the counts along the Okaukuejo-Namutoni road do not include game seen within 8-10 miles of Namutoni. That area is dealt with separately from the d.s.c.a.

numbers declined during the rains, but the drop was not as spectacular as for zebra. It was noticed that most of the former two animals counted from the Okaukuejo-Namutoni road in January and February were concentrated about 3 miles west of Rietfontein. Here the plains bordering the pan (vegetation type 1) extend southward to form a fairly large enclave in the savannah. The vegetation is very similar to that of the w.s.d.a., which may account for so many of the antelope remaining there.

Gemsbok and giraffe were found at about the same level of abundance as during the dry months.

(*b*) W.S.D.A.

On 28th December, 1956, the usual dry season population was found on the short-grass plains of the w.s.d.a. but there were small herds of zebra at Leobrunn. These and the wildebeest seen earlier (19-11, 18-12, Table 6) near Okondeka indicated the commencement of westward migration. The next visit took place on 14th February, 1957. An impressive change in the game population was apparent. Between Okaukuejo and Leobrunn and thence to the Groot Vlakte herds of zebra, wildebeest and springbok were numerous and widely spread. Very few gemsbok and giraffe were seen however. On the Groot Vlakte the total of the three migrant species was estimated at 10,000 head. The scene was one to be remembered — green grass, rainwater-filled pans and an incessant noise caused by mothers and their offspring calling constantly to each other.

Conditions were very much the same on 22nd February, but by this time the grasses and forbs showed signs of drying up and many of the rainwater pools were empty. On 25th February I found that the Groot Vlakte had been abandoned and only a few springbok and ostriches, about 20 gemsbok and 1 wildebeest were counted. By using binoculars, however, a dark mass of game could be distinguished on the northern edge of the plain. Flying over the area on the same day the Chief Game Warden saw several thousand head of wildebeest and lesser herds of zebra and springbok trekking fast along deeply trodden paths leading E.N.E. They appeared to be passing north of Adamax and making for the pans west of Okondeka where water and grazing was still plentiful.

In the triangle between Okaukuejo, Okondeka and Adamax, migratory game was present in small numbers during January and February, 1957. In March there was an influx. Thus on 10th March approximately 2,000 wildebeest and 1,000 zebra were in sight along the first 5 miles of the Okaukuejo-Okondeka road. On the same day several hundred wildebeest and rather fewer zebra were grazing near the Okondeka-Adamax road and masses of wildebeest could be seen at the pans to the north, whither they had trekked on 25th February. From Leobrunn to Okaukuejo all three species were encountered in good numbers and one remarkable herd of c2,000 springbok was recorded.

From 15th March, when some 1,000 wildebeest, 900 springbok and 33 zebra were counted about the Okaukuejo airfield, numbers began to drop. On 9th April a tally made on the Okaukuejo-Okondeka road gave a total of 300 zebra, 20 wildebeest, 25 springbok and 2 gemsbok. The end of April also marked the end of the wet season pattern of game distribution.

To summarise, migrants began to appear in the w.s.d.a. in December, 1956. We do not know when the main herds arrived but by mid-February, 1957, the Groot Vlakte was densely populated. Towards the end of that month game moved away from the Groot Vlakte to areas where water and grazing was still available, without leaving the w.s.d.a. however. Game density declined during April and by the end of the month the migration was over.

The pattern followed in the 1957-58 rains differed somewhat in detail. After the first shower (9.5 mm.) had fallen at Okaukuejo on 20th October, 1957, we rather expected migration to start immediately. Investigation showed that the daily trek to the waterholes in the d.s.c.a. was checked for a few days but the game soon reverted to its normal routine. Green grass

near Ondongab, where precipitation must have been higher than elsewhere, brought about a minor temporary concentration of migratory species which dispersed when the grass dried. There was at this time no change in the population of the w.s.d.a., nor was it possible to establish when the influx into that zone started. However, by 27th November, 1957, zebra, wildebeest and springbok were already numerous, as the following field notes show:

	Z	Wb	Sp	Gb	Lion	Ostrich
Ok-Okondeka	65	c280	c920	2	7	323
Okondeka-Adamax	—	c240	c1,240	—	—	—
Groot Vlakte	c75	c450	c650	—	—	c40
Leobrunn-Ok	c50	c110	c750	4	2	—

The relative smallness of the zebra herds may be correlated with our suggestion (see under (*a*) above) that they migrated late. It is noteworthy that so very few gemsbok and no giraffe were seen (cf. Table 6).

TABLE 8.

Wet Season Game Counts.
Wet Season Dispersal Area.

Date	Route and Distance		Z	Wb	Sp	Gb	K	H	Gir
8-1-58	Ok - Okondeka - 4 miles along Adamax road ..	18m.	c90	c1,185	c1,360	3	—	—	—
24-1-58	Ok-Leobrunn (out)	12m.	c270	c225	c35	—	—	—	—
	(return)		c125	c115	17	—	—	—	—
24-1-58	Leobrunn-Adamax (out)	7m.	—	c200	c300	3	—	—	4
	(return)		7	c50	c450	—	—	—	5
24-1-58	Adamax along northern edge of Groot Vlakte..	c10m.	c50	c500	c40	1	—	—	—
	(return)		—	c335	c355	3	—	—	—
24-1-58	Road to west through Perennial savannah (p.w.s.d.a. map 2) (out)	c40m.	—	—	—	25	—	10	—
	(return)		—	—	—	23	2	10	—
8-2-58	Ok-Okondeka	14m.	5	183	c730	c80	—	—	—
8-2-58	Ok-Adamax	9m.	c95	c490	c995	—	—	—	—
8-2-58	Adamax-eastern edge of Groot Vlakte ..	c8m.	c370	c650	—	—	—	—	—
19-2-58	Ok-Leobrunn	12m.	20	c535	c75	—	—	—	—
19-2-58	Leobrunn-eastern edge of Groot Vlakte ..	15m.	c250	c295	c2,050	1	—	—	—
19-2-58	Groot Vlakte		c150	c500	c70	1	—	—	—
19-2-58	Groot Vlakte-Adamax ..	c8m.	c150	c200		—			
19-2-58	Adamax Windmill ..		—	—	—	29	—	—	—
22-2-58	Ok-Leobrunn		c40	c950	—	1	—	—	—

Abbreviations:
Game species as in Tables 3 and 4; localities as in Table 4.

Various counts made later in the rainy season (Table 8) show that migratory species were well represented all over the w.s.d.a. Once again they were accompanied by new-born young in profusion. However we did not observe a concentration on the Groot Vlakte comparable with that of February, 1957. The reason is speculative. A congregation may have occurred and not been seen or conditions may have been simultaneously favourable over a larger area than in 1957, in which case the animals would probably have been more widely dispersed. Gemsbok and giraffe numbers were generally much lower than in the dry season and no eland were seen.

The first intimation that migrants were leaving the west was given by a report from a passing official. On 7th March, 1958, he travelled from Ovamboland to Okaukuejo along the western edge of the pan and saw big herds of wildebeest trekking northwards towards the Native Reserve On the same day numbers of zebra were observed moving eastwards in the country between Okondeka and Okaukuejo.

I was fortunate in being able to watch large troops of zebra returning to the d.s.c.a. on 7th, 8th and 9th March (Table 7) They moved eastwards along the southern margin of the Etosha Pan and travelled steadily, although at no more than a fast walk, strung out Indian file in long lines. Paths several inches deep were left where they had passed. Many grazed as they walked and a good percentage of the mares had young foals.

The bulk of the game had left the w.s.d.a. by 19th March, when only 160 wildebeest, 41 zebra and 13 springbok were recorded between Okaukuejo-Okondeka and Leobrunn. Thus the 1957-8 migration started some time in November and ended in March.

(*c*) P.W.S.D.A.

This area has been separated from the w.s.d.a. as we have only a little information by which to judge its status. On 2nd January, 1958, a grader operator returned to Okaukuejo after making a road from Adamax across the northern part of Groot Vlakte and through this zone. He had progressed for about 50 miles when he was forced to stop work because of heavy rains. He reported that game, apparently chiefly zebra and wildebeest, had been plentiful along his route. Unfortunately the condition of the road prevented me from following this lead. However, his report tallies with my own observations in June, 1957, when the same general area was explored. Old zebra and wildebeest tracks and droppings, the consistency of the latter suggesting that the animals had been eating green grass, were then found to be plentiful. When this sector was patrolled on 24th January (Table 8, "road to west through perennial savannah") the herds reported at the beginning of the month were not seen but by then the country was dry.

It is on this circumstantial evidence that I have tentatively designated the country concerned a probable w.s.d.a. Further work may well show that it is a part of the w.s.d.a. proper.

Discussion

The two successive migrations differ mainly in the time at which they took place. The first started late in December, 1956, and the animals left the w.s.d.a. in April, 1957. The second got under way early in November, 1957, and the return trek of the bulk of the game took place early in March of the following year. An analysis of the rainfall at Okaukuejo, which gives some indication of that in the adjacent parts of the Park, shows similar differences in the two periods (Table 9).

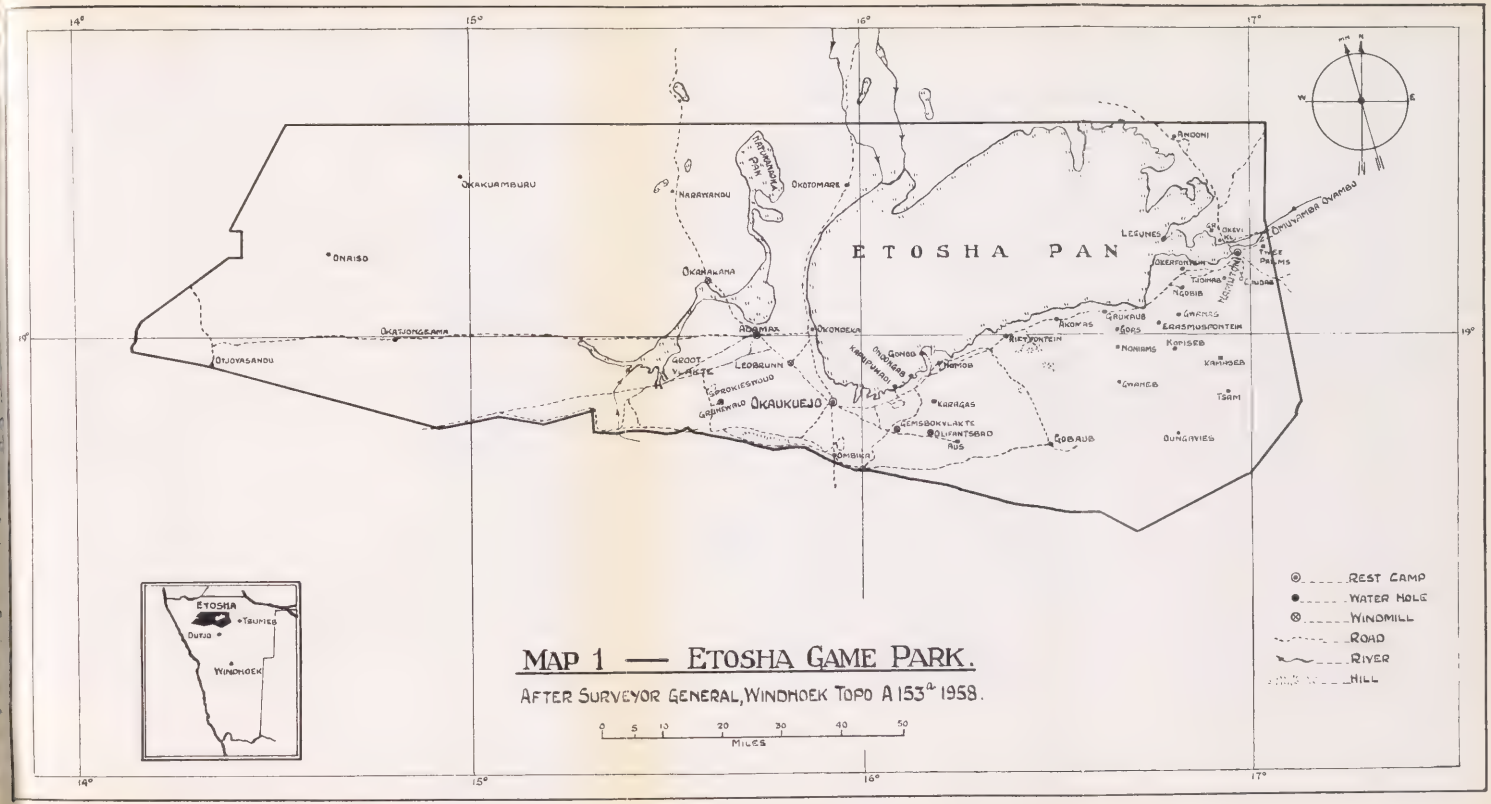
TABLE 9.
Analysis of rainfall (mm.) at Okaukuejo.

Month	Mean of 24 years	1956-7		1957-8	
		Actual rainfall	Rainfall as % of mean	Actual rainfall	Rainfall as % of mean
October	13·5	0	0%	9·5	70·4%
November	33·5	21·5	64·2%	91·8	274·0%
December	92·3	32·5	35·2%	115·7	125·4%
January	90·1	77·8	86·3%	101·9	113·1%
February	115·4	104·3	90·4%	70·9	61·4%
(*a*) February 1-15	—	—	—	67·4	—
(*b*) February 16-28	—	—	—	3·5	—
March	83·1	65·1	78·4%	?	?
(*a*) March 1-10	—	39·0	—	2·3	—
(*b*) March 11-31	—	26·1	—	?	?
April	27·5	10·9	39·6%	?	?

The fall in November, 1956, was low, that of the following month somewhat higher (absolutely) but well below the mean. Only from January to March, 1957, did the total precipitation approach the mean values for those months while April was relatively dry again. Very heavy rain was recorded in November, 1957, and above-average totals were attained in December and January, 1958. The figures for February and March are the most interesting however. From 16th February until 10th March only 5.8 mm. was registered, which dovetails neatly with our observation that emigration from the w.s.d.a. started on 7th March.

There would thus seem to be a correlation between rainfall and migration. This suggests that migrants alternate between two distinct regions because of food and water requirements. A working hypothesis has been built up on this basis, and it appears to fit the facts. We assume that the typically migratory species, zebra, wildebeest and springbok, prefer young green grass and forbs to other types of food. These are most readily obtainable in the w.s.d.a. during the rainy season, since the dominant grasses there are annuals. The d.s.c.a. has mainly long perennial grass and when new shoots appear they grow from the tussocks left over from the previous year. Thus quantities of tough fibrous old material must be ingested with the green shoots and the animals find grazing in the w.s.d.a. more palatable. In the dry months however the pasture of the w.s d.a. has, on the whole, a very low feeding value while that of the d.s.c.a. retains a good deal of nutriment. Most of the game therefore concentrates in the latter zone. The fact that pans of fresh water are found throughout the w.s.d.a. during the rains, whereas it is not well watered for the rest of the year, may add to its attractiveness. On the other hand, the availability of water cannot be the prime factor causing the migration. There are windmills in the w.s.d.a. which pump throughout the year, yet game only increases in the rains. Conversely, the d.s.c.a. is well watered all the year round but its population drops during the wet months.

This hypothesis may oversimplify the picture. Factors such as the psychological preferences of game and differences in the trace elements found in various areas may yet prove to be of importance. The fact that parturition takes place in the w.s.d.a. may be another contributory cause. However, research on the behaviour of other ungulates lends support



MAP 1 — ETOSHA GAME PARK.

AFTER SURVEYOR GENERAL, WINDHOEK TOPO A 153ª 1958.

to the view that alimental factors are of great significance in causing seasonal movements. Thus Fraser Darling (1937) found that red deer (*Cervus elaphus*) forsake the hills of the Scottish highlands for the valleys when snow falls, partly at least because snow covers their food plants. Similarly the extensive migration carried out by elk (*Cervus canadensis*) between highlands and lowlands in parts of America is closely related to the presence of snow on the former (Altmann, 1952). In summer the lush green pastures of the highlands stand in contrast to dry conditions in the lowlands. Buffalo (*Bison bison*) "returned to the higher meadows again with the disappearance of snow in May or June" (McHugh, 1958).

Molloy (1957) has given a graphic description of the movement of white-eared kob, tiang, eland, etc., estimated at a million head, from the dry-weather grazing grounds on the Pibor and Akobo Rivers southwards to the Topotha plains in S.E. Sudan after the onset of the rains. He writes: "There has been much speculation over the cause of this movement, but it seems fairly clear that the basic motive is a search for grazing, while flooding of the upper Nile plains in the rear may be a secondary cause." Vesey-Fitzgerald (1954) considers grazing and water to be the main factors which cause the plains' game (wildebeest, hartebeest, zebra, Thomson's and Grant's gazelle) of the Athi-Kapiti plains in Kenya to alternate between dry season concentration areas and wet season dispersal areas. Finally, we may point to the Serengeti plains in Tanganyika, "dry grasslands, verdant only in the wet season, their water supply being too scarce and too saline to be adequate for use in the dry" (Pearsall, 1957), which are only grazed by game in the wet season, and then by several hundred thousand head.

Turning now to the immediate stimuli which make the animals collect together and start migrating, there are probably several. As the dry season progresses, grazing becomes increasingly dry and tough and green vegetation is eagerly sought after. The behaviour of two tame springbok and a gemsbok kept in the camp at Okaukuejo illustrates this nicely. The animals lived on the natural veld enclosed by the camp fence and as the area is large there was no question of undernourishment. Yet as the dry season continued they paid much attention to garden trees, shrubs and creepers and nibbled all the green leaves and shoots they were able to reach, although most of the plants were foreign to the Park and unknown to the animals. Indeed strong measures were needed to prevent total destruction of the garden. The quality of the drinking water at many of the holes in the d.s.c.a. probably also worsens during the course of the dry season. The pools gradually decrease in size and through daily use they become muddy and sullied with excrement. It seems likely that those with saline water show a rise in the concentration of salts due to evaporation.

We believe that the steadily depreciating quality of grazing and water has a cumulative effect, building up the animals' receptiveness to any stimuli that might indicate a change. When rain does come it is probably smelt over a great distance. Man with his poor nose can detect a shower for several miles, as I have found by personal experience. Most other mammals can almost certainly do much better. Thus smell and some sort of memory of the direction in which succulent grazing was found in the previous year could bring about movement.

A final point calling for discussion is the origin of the animals found in the w.s.d.a. during the rainy season. Probably some springbok are resident throughout the year. We have seen that game numbers decrease in the d.s.c.a. during the rains and as a migration back to this tract has been observed it is certain that some of the resident herds move westward to the w.s.d.a. But can these two sources account for all the migrants? It does not appear so. We have already mentioned a report that wildebeest were seen trekking *northwards* in March, 1958. It has been established that these animals are abundant in southern Ovamboland in the dry months. Late in October, 1957, approximately 10,000 were seen there on a patch of burnt grassveld some 10 miles square. We know that the plains of Ovamboland are dominated by perennial grasses and that they are often flooded in wet weather, a com-

bination of circumstances which would make them unattractive to game at that season. The evidence points to the probability that some of the game, or at least some of the wildebeest, found in the w.s.d.a. of the Park comes from Ovamboland.

Namutoni Area and Andoni Flats

Until the appointment of a ranger at Namutoni in May, 1957, no continuous record of the animal life in that sector was available. This account has been compiled chiefly from his monthly reports.

Elsewhere in this paper the vegetation and soils of the tract surrounding Fort Namutoni have been described. The density of the bush beyond the plains bordering the pan and the occurrence of seven permanent waterholes within a radius of about 4 miles of the fort are important influences on the constitution of the fauna. The ubiquitous zebra, wildebeest and springbok are the commonest ungulates but kudu (*Tragelaphus* (*Strepsiceros*) *strepsiceros* Pallas) are probably more numerous here than anywhere else in the Park Eland and giraffe numbers are also high, elephants (*Loxodonta africana* Blumenbach) were seen consistently throughout most of 1957 and duiker (*Sylvicapra grimmia* Linn.) and Damara dikdik (*Madoqua kirki damarensis* Günther) are abundant only in this part of the Park. Gemsbok are however very scarce indeed.

The reports for July, August and September show that large ungulates and particularly the three migrant species were abundant during the dry season. The first rain fell in October, upon which "literally thousands of springbok, zebra and wildebeest" invaded the plains around the fort. Possibly those resident in the eastern part of the d.s.c.a. were responsible for this congregation; alternatively there may have been a southward movement from Ovamboland. In November good rains fell and the grazing was green and succulent. Wildebeest and springbok were still abundant but both here and on the Andoni flats zebra became remarkably scarce. In December the numbers of all three species again reached a high level around Namutoni and conditions remained thus in January and February.

These notes show that the only indications of a migration were an increase of zebra, wildebeest and springbok after the first rains and a scarcity of the former in November. Until detailed information is available for a longer period, it would be unwise to formulate general conclusions on the movements of ungulates in the Namutoni area.

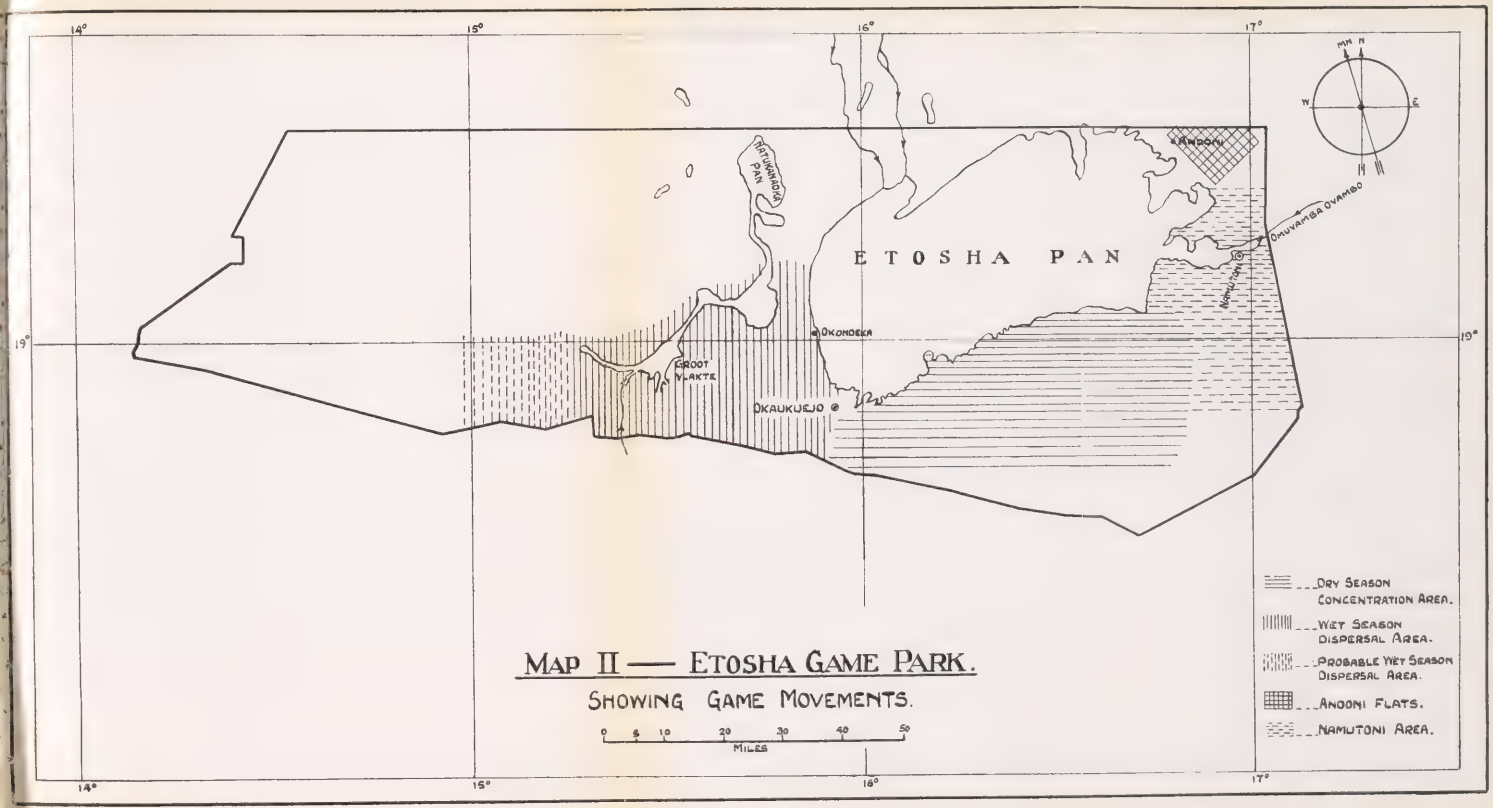
During the dry season the Andoni flats do not seem to support a large resident game population. At the end of the rains, when the grass was green and rainwater still abounded (30th April, 1957), 1,000-1,500 wildebeest, several hundred zebra and perhaps 100 springbok were seen there. On 20th October only a few head were observed. On 24th October, however, 304 wildebeest and 469 zebra were counted from the road –an immigration was apparently under way. When the ranger next patrolled the flats on 1st November, he counted 2,435 zebra about Andoni waterhole and a further 71 wildebeest and 621 springbok on the plains. Later in the month (date not given) he saw only a few hundred springbok. It was at this time that zebra became scarce at Namutoni.

Another immigration must have taken place because on 28th December between 5,000 and 6,000 wildebeest, but very few zebra and springbok, were grazing on the flats. They moved away again and on 19th January, 1958, only 20 wildebeest were noted. From that date until the end of February the game population remained at this low level.

Thus it appears that big herds do occupy the flats intermittently during the rains. The plain has the status of a w.s.d.a. at times but more information is needed to understand game movements here fully.

Summary

Observations on the ecology of the Etosha Game Park, a sanctuary in South West Africa, are recorded. A short description of the climate, topography, soils, vegetation and water


14°
15°
16°
17°
19°
ETOSHA PAN
ANDONI
OMUVAMBA OVAMBO
NAMUTONI PAN
OKONDEKA
GROOT VLAKTE
OKAUKUEJO
NAMUTONI
MAP II — ETOSHA GAME PARK.
SHOWING GAME MOVEMENTS.
0 5 10 20 30 40 50
MILES
DRY SEASON CONCENTRATION AREA.
WET SEASON DISPERSAL AREA.
PROBABLE WET SEASON DISPERSAL AREA.
ANDONI FLATS.
NAMUTONI AREA.

supplies of the Park is given. Marked differences were found between the distribution of the dominant ungulates, zebra, wildebeest and springbok, in the dry season (May-September) and in the wet season (October-April): they confirm, in the main, the general descriptions of two older workers. In the dry months the bulk of these animals range over a dry season concentration area characterised by long perennial grasses and abundant surface water. After the onset of the rains most migrate westwards to a wet season dispersal area with annual grasses and temporary rainwater pools. Here they are probably joined by others, perhaps mainly wildebeest, which migrate southwards from the Ovamboland Native Reserve. Here also parturition occurs. The hypothesis that the migration is primarily a response to differences in the palatability of the grazing and the availability of water in the two areas concerned, is put forward. Other large ungulates which appear to perform more or less regular, but as yet poorly understood, seasonal movements are gemsbok, giraffe and eland. The status of some parts of the Park in relation to game migration is doubtful or unknown.

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JAMES A. BATEMAN
KAFFRARIAN MUSEUM,
KING WILLIAM'S TOWN.

The Discovery of Elephant Remains in the Aberdeen District, C.P.

It is well known that there have been no authenticated reports of the presence of elephant in the Karoo region during historic times. Therefore, the discovery in November, 1958, of the skull, complete with tusks, of an extant African elephant on the farm "Glencliffe", at the western tip of the Camdeboo Mountains and twenty-seven miles north of Aberdeen on the Murraysburg road, is of interest.

The skull was not fossilised and of no great age, although some decomposition had taken place.

The remains were embedded in alluvial soil at a depth of twelve feet from the surface and had been exposed by floodwater erosion of the river bank, being at the junction of two streams. The uncovering of the skull was also aided by a change of course, during the last thirty years, of the stream in which it was found. Since excavations were not carried out it is not known how much of the skeleton was present.

The features exposed showed that the skull was inverted with the tusks arching into the ground (see plate). The premaxillaries were already crumbling. On arrival at the site the right tusk was still intact, but the left was broken off some twelve to fifteen inches from the root. Originally the tusks must have been about four feet six inches long, although the complete one showed signs of wear and tear, being rounded at the tip and suggesting that the animal was quite old at death. Taking into account the type of material in which the skull was embedded, it was fortunate that the decay had not reached a more advanced stage. Only the durability of the ivory, compared with the bone of the remainder of the skull, enabled the intact tusk to be removed to the Kaffrarian Museum, where it is preserved as a record of the discovery. The condition of the remainder of the skull showed the impracticability of attempting its removal in one piece, since even a slight touch caused the bone to disintegrate. As it was, the tusk that was removed broke into two pieces, whilst being eased from the depression in the soil, where it was lodged.

The morphology of the skull indicated that the elephant was of the modern type, *Loxodonta africana africana* Blumenbach, and it was estimated that at the time of discovery the skeletal fragments could have been at least three hundred years old. It was not possible to confirm this scientifically, but bearing in mind that Schrijver (Mossop, 1931) made no mention of elephants during his extensive journeyings in and around the valleys neighbouring "Glencliffe" in the year 1689, and had they been there he would have surely seen them or their spoor, the estimated age cannot be much less than three hundred years.

Site of discovery of Elephant skull at "Glencliffe", Aberdeen, with skull *in situ* in the stream bank. Right tusk shown broken off at base.

Mr. J. M. van Niekerk, the present owner of "Glencliffe", came across another tusk, farther upstream, in 1921, so that the present discovery was not an isolated find and could not have been a discarded trophy owing to its position at the base of a layer of silt. The 1921 specimen was said to be in good condition and was sent to the National Museum, Bloemfontein, where, unfortunately, it cannot now be traced. The Curator of Reinet House, Miss M. R. Haarhoff, reported the presence there of a tusk donated by Mr. J. H. J. Smith of the farm "Bulrivier", Marais Siding, Aberdeen. Subsequent enquiry revealed that this had been located during the floods of 1941 on the farm "Pretorius Kraal" in the Jansenville District, some twenty-four miles north-west of the town of Jansenville. It had been lying in the Sundays River, which runs through the farm. There is another record from Mr. H. James of Cradock (per Mr. G. E. D. Briscoe, *in litt.*) of the discovery of a tusk at Halesowen, along the Fish River.

Shortridge (1934) quoted Barrow as indicating the presence of elephants in the coastal strip around Knysna and extending northwards as far as Graaff Reinet, although an examination of Barrow's account has failed to reveal this. Shortridge also mentions the presence of elephant remains, including tusks, portions thereof and molars, in the Albany Museum collection and gives their origins as Doornhoek, Conway and Tarkastad. Lichtenstein (1815) made no mention of having seen elephants during his widespread travels through the Karoo in the years 1803-6, in fact he described the region as being completely devoid of game at the time that he passed through.

Taking these various discoveries into account it would appear that elephants must have roamed up the river valleys from the coastal strips, where they had been known to abound,

and into the Karoo. Whether the animals' movements resulted in permanent occupation of the Karoo, or were only occasional infiltrations via the waterways, cannot be established with any certainty. That the elephants should have kept to the valleys would seem natural, since their water requirements are known to be phenomenal.

Acknowledgments

Grateful thanks are extended to the Secretary of the Aberdeen Divisional Council for information leading to the site of discovery, to Mr. J. H. J. Smith for details concerning his discovery of elephant remains and particularly to Mr. and Mrs. J. M. van Niekerk for their kind hospitality and assistance, whilst investigations were being made at "Glencliffe".

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R. LIVERSIDGE, B.Sc.

PORT ELIZABETH MUSEUM.

The Wattled Starling (Creatophora cinerea) (Menschen).

There has been little original contribution to the biology of this species for many years. Much that has been written would appear to have been obtained from the same few sources published about the turn of the century. Recent information that has been published is derived mainly from avicultural sources and has concerned the moult of the male bird. This moult, involving the change from feathered head to naked skins and wattles (gymnocephaly) is known in only two species of bird as a seasonal phenomenon.

There is still much to learn about the species. It is apparent from the literature that there is probably a difference in several details between the southern populations and those found north of the equator, and for this reason all information from the Eastern Cape has been given. The following is based mainly upon 24 hours of observation of a breeding colony of some four hundred nests on the farm Boschkraal, Kirkwood in the Sundays River Valley. Much information has also been obtained by private communication especially that collected by Mr. J. Sneyd Taylor from an enquiry made into the species in 1953.

General Behaviour

The Wattled Starling is not uncommon in the Eastern Cape, though it is predominantly seasonal in its occurrence. It is a social species that usually occurs in flocks. Small numbers, say from one to six individuals, most frequently associate with other flocking birds. The bigger groups may also associate with other species but the larger the flock of Wattled Starlings, the more likely that it does not mix with other species. The larger flocks are more often observed in July and August except in the presence of locusts. Locusts occur in summer and even in these days a swarm may be followed by a flock of over 1,000 Wattled Starlings. (S. H. Rubidge, Graaff-Reinet. December, 1953.)

In the Eastern Cape the Wattled Starling associates very frequently with the Pied Starling (*Spreo bicolor*) but much less often with the Cape Weaver (*Ploceus capensis*); these two species themselves often associate in mixed flocks, and Pym (1910) also records association with the Red-winged Starling (*Onychognathus morio*). In Central Africa association is recorded with Glossy Starlings (*Lamprocolius chalcurus* and *L. chloropterus*) and, curiously enough, Oxpeckers (*Buphagus* species). Wattled Starlings do not associate with the Glossy Starlings (*L. nitens* and *L. coruscus*) in the Eastern Cape. Both these Glossy Starlings are inhabitants of the moister evergreen coastal vegetation and where *L. nitens* occurs, in the drier parts, it is not usually a flocking species, at least not normally gathering in large numbers. In Central

Africa as well as in the Eastern Cape, the association of the Wattled Starling is with flocking species that frequent the dry open country.

The flocks rove about, gipsylike, so that one can never rely on finding the species in the same area for long.

The birds themselves spend most of their time feeding on the ground, strutting about much as the European Starling (*Sturnus vulgaris*) does. Less often do they feed in the trees, and when disturbed, they fly away in a manner similar to the European Starling, in a straight line, with rapidly beating pointed wings. A small flock may circle round to settle nearby on the ground or in a tree. A large flock when alarmed will fly off some distance, usually with a few accompanying squawks. The flock remains in close formation and this, combined with twisting and turning in unison and showing the white rump frequently, is very characteristic of the species. Generally speaking it is not a very wild bird, but is certainly not as confiding as the Pied Starling. This is known to frequent human habitation and Roberts (1933) records them feeding about slaughter houses.

The Wattled Starlings usually roost in large numbers which forgather in low trees or reedbeds. They gather before sunset and are restless before settling down for the night, but in the non-breeding period they settle without calling. At the approach of the breeding season their habits change in that they carry on aerial manoeuvres accompanied by a continuous chatter before settling down. This behaviour continues throughout the breeding period.

Distribution

The ecological distribution of this species has long been associated with locust breeding sites. In Southern Africa this has become more of a historical fact than a true reflection of the existing state of affairs, since the locust no longer breeds freely without control measures being taken. However, despite this, the birds are still able to keep up with the breeding locusts. Two observers (W. J. Quinton and S. H. Rubidge) reported from the Karroo in 1956, that large numbers (1,000 plus) of Wattled Starlings had been observed in the presence of hoppers whilst under normal conditions (without swarms of hoppers) the species was either considered rare or had not been noticed previously. A further report on a large nesting colony near Queenstown stated that the colony was bigger than 3-4 years previously and this seemed to coincide with the great increase in the grasshopper population that year. The species is not dependent upon the locust for breeding in the Eastern Cape since most recent observations indicate breeding colonies without mention of hoppers.

In the Eastern Cape the species is found throughout the drier regions. Such habitats as the dry xerophytic vegetation described by Acocks (1951) as Valley Bushveld or Thornveld are typical of its haunts. In the vicinity of Port Elizabeth the open, dry, valley systems of the Sundays, Swartkops and Coega Rivers form its favourite haunts. Here the habitat consists of scattered small-leaved acacia trees situated in open grass-covered ground.

The starlings may occur anywhere in the region, but it is exceptional to find them in the moister habitats such as the coastal bush or thicker forests.

The seasonal movements of the Wattled Starlings have also been associated with the locust movements. Though Roberts (1932) considers there may be some migratory movement in the species, the situation is aptly summed up by Gill (1936), "roving, appearing almost anywhere for a time in flocks, then disappearing".

Where the species breeds, it is common in the summer months, though good rains in a particular district will tend to attract the summer birds there. Anderson (Gurney 1872) states that the birds are migrants "arriving in the rains, departing on return of the dry". Where it has not been recorded breeding the species is often only found as a winter visitor. Winterbottom (1959) refers to the species as a winter and spring visitor (to Northern Rhodesia)

from some place west or south-west. It is probable that immature birds from late breeding elsewhere will contribute to the confusion when they wander.

It is worth noting in relation to the seasonal movements that the hoppers usually hatch after rains during the summer and it is probable that this fact is "known" by the Wattled Starlings which always seem to turn up at the right place at the right moment. Lea (1958) reports that locust increases most often follow a season in which the early summer rainfall was low. In connection with this, three correspondents relate that these birds do not breed every year in an area but only after good seasons. This would imply that the previous year was a dry year and thus, according to Lea's findings, the hoppers would be more plentiful than normal. W. F. Quinton writes that the birds occur in the Beaufort West area usually after rains and that in 1956 after abundant rains the birds, previously considered rather rare and unknown to have bred, suddenly appeared and established a large breeding colony. From this information it would appear that the occurrence of rain itself attracts the birds. This, however, is not the whole picture since the colony at which the following observations were made, was established during one of the severest droughts in the Eastern Cape for many years; this site had previously been occupied during unusual flooding. Nesting under unfavourable conditions is recorded but is generally the exception to the rule.

In the Eastern Cape the picture is more complete. Over the dry inland areas where the species may breed it is primarily a summer resident that wanders to those districts where good rains have occurred; in these areas vagrant flocks may occur throughout the winter too. There is a wide winter dispersal which extends to moister regions where it does not breed, and the coastal areas where it is almost entirely a winter visitor. The movement is thus a dispersal rather than a formal migration.

Food

It was stated by Reichenow at the turn of the century that this species is absolutely dependent upon locusts. Whatever the state of affairs was then, this is certainly not the case these days, though the birds may turn up in new localities on the appearance of locusts. Evidence is also given by Vesey-Fitzgerald (1955) that it is not only in the Eastern Cape that the species is no longer dependent upon locusts, but also in Rukwa valley in S.W. Tanganyika where the Wattled Starling has not been seen to attack locusts in any stage.

The most abundant recorded food is locusts in various stages, even including burnt locusts consumed after a grass fire. Insects form the bulk of the food with records such as "chiefly small coleoptera"; "beetles and sand"; "grasshoppers and many beetles". The breeding colony at Kirkwood fed largely on a brown grub (not identified) and during irrigation of farmlands brought in brown and green grasshoppers, dipterous-like larvae, a transparent-winged insect and a worm. Worms are recorded several times.

There are also several references to fruit, especially from material from S.W.A. Hoesch (1940) also mentions fruit and Chapin (1954) identifies the berry of *Ziziphus mucronatus*. Berries, probably from *Azima tetracantha*, were also found in a bird in very fat condition.

Voice

Compared to other members of the *Sturnidae* in non-breeding periods this is a silent species. In a large flock it will be one or two individuals alone that call the alarm squawk.

The normal song is described by Joubert (1945) as similar to that of the Rosy Pastor, complete with imitations of other birds, save that it is harsher and more squeaky. It is a rambling raucous song interspersed with pleasantly whistled notes. Parts such as an oft-repeated "squeezily-squeeze-squeeze" are recordable but most is beyond description.

The alarm in flight is a double "squeeky-squawk", but there is also another flight call which small groups utter, a less harsh triple-syllabled phrase. At the nesting site there is

another alarm note, a single nasal "graaaaah", rather quiet and deep, that cannot be heard from very far off.

During nesting, the close packed colony is a babble of noise with birds calling and singing all about the nesting trees. The noise can be heard before the nests themselves can be seen and this serves to aid one find their nesting colony. Their combined noise is considerable and vies with that of any other member of the starling family under these circumstances. The clatter of calling young waiting for food is as loud and must be heard to be believed.

The females utter a high-pitched twittering when soliciting the males. They also call when coming to the nest; this is the flight call uttered some yards before reaching the nest.

When singing the bird assumes an unusual stance. The feathers are slightly fluffed; the head and neck are drawn in a little and lowered so that the impression given is of a hunched up attitude. When singing the head is moved up and down in a sort of pumping motion from a higher horizontal position to a lower upward-sloping position. Whilst thus 'pumping' the peculiar song is uttered.

Plumage

The unique seasonal change of appearance of the male bird is well illustrated in the accompanying plate. The picture depicts the same bird in breeding and non-breeding condition, and was taken from birds kept in the London Zoo. With the same experience in the aviaries at the Port Elizabeth Museum there is no doubt that such a change is normal. It may be noted, however, that it was not very long ago that this matter was still open to criticism because some aviary birds had not produced the wattled condition after several years.

Observations in the Eastern Cape show that birds in the wild usually show no, or very little, naked skin or wattles except for a period from September (rarely late August) to January or sometimes later to March when breeding is late. According to Chapin the same breeding condition is recorded from April through to November-December in the Congo. Both these periods coincide with the known breeding times in the respective regions. Even during the period when wattles may be noted, very few in a flock show much indication of wattling. In one observation only three out of ten birds showed any distinctive change. Chapin (1954) doubts that there were more than two bald males in a breeding flock of forty or more birds. This agrees with local observations where one male in about twenty nests showed the full wattled condition. The wattles and naked skin are lost as breeding progresses; in the colony under observation there was only one 'bald' male left when the young were already clambering about the trees.

The presence of wattle and naked skin on the female has been overlooked by most workers. Roberts (1940) mentioned it, basing his information on an original observation by Dr. H. Exton recorded on an interleaved copy of Layard's "Birds of South Africa" (1867) (see Roberts 1935). Exton wrote that he had shot eight females "one combed and wattled, I thought to be a male, but on dissecting it it proved to be a female; plumage that of the female but having the comb and wattles of the male, the ovary fully developed, a physiological curiosity".

It has been shown by Crandell (1949) that males with large wattles and much naked skin are older birds. Young birds kept in captivity for one year merely show black malar regions with a small area of black on the lores; these are presumed first year male birds. Presumably it is only old females that show wattles or bald regions. Thus in male and female birds there is a complete gradation according to age, with the probability that the males show the 'breeding condition' at an earlier age than the female. This explains the statement (see Friedmann 1937) that the state of the wattles in no way indicates the condition of the reproductive organs, for in actual fact breeding birds may not necessarily have wattles. All observers at the Boschkraal colony were utterly confused when attempting to determine sexual differences between nesting pairs.


E.M. HENRY

It is stated in nearly all general works that the female has the primary coverts black and the male has these feathers white. This is not correct in Southern Africa where an inspection of male skins shows considerable variation. The male primary coverts may be pure white, grey or with outer webs only, white; this pattern may or may not extend onto the neighbouring few secondaries. There would appear to be no connection between the presence, absence, or extent of white and the presence or absence of wattling; though no advanced wattling occurs with grey coloured coverts. No skins of females examined showed wattling. The impression gained in the field was that some females were wattled, the older lighter females more so than others. Also it was believed that some advanced females had white primary coverts. It should be stressed that sexing was based upon individual behaviour of the pairs at their nest and, whilst the species appears to be monogamous, the possibility of incorrect sexing is not overlooked. However, with three independent observers, the same conclusions were arrived at; namely that only a few old males in the colony had advanced baldness and wattled heads; that some of both sexes had naked skin around the eye and forehead with a small "dewlap" and small front "carbuncle"; that of these latter there was apparently no consistency in colour of primary coverts except perhaps that older birds (male or female) had white primary coverts; that some breeding males and females had only the yellow skin about the eye and the black on the malar and chin. This last condition is similar to birds one year old.

Young birds are distinguished for the first few weeks after leaving the nest by their noticeably shorter tails. Once the tail has reached normal length it is not possible to distinguish them in an aviary from non-breeding adults.

There is considerable individual variation in the wattles. There are two lobes on the chin which hang down side by side and there are two lobes on the forehead, one in front of the other. The pair above, or either one above, may be very much larger than the rest. In one aviary kept bird the lower lobes were dominant for the two successive 'breeding' periods it has been in captivity.

Geographical Variation in Plumage

Though no races have been named there is a cline in body colour from a buffy white in the south through to a smoky grey in the north. Birds from the Cape Province and Orange Free State are lighter, except for one specimen from Zoetendalsvlei, C.P., whilst birds from Swaziland, Bechuanaland and the Rhodesias tend to be darker. There is comment from one correspondent in Natal having seen and collected very much whiter birds than normal. The series of thirty specimens from the Transvaal Museum were inadequate to come to any conclusions on this matter. Field impressions at the breeding colony were that older birds were lighter coloured, though the range of variation was never as much as that shown by the skin series.

General Notes on Breeding

It is the unusual breeding behaviour of this species that has attracted much attention and in particular the mass breeding that is so wonderfully timed to coincide with the mass hatching of locusts. Webb (1951), quoting the notes of R. Hook, was the first to draw attention to the fact that there are two distinct modes of breeding. In the ordinary way the birds breed in small colonies of anything up to four hundred nests. The more unusual way is far more erratic and unpredictable and is dependent upon the breeding of locusts, on these occasions nests number "thousands and thousands" and extend for hundreds of yards.

The colony breeding at Boschkraal returned to the identical trees that had been used some years previously. Maj. E. Wolley had recorded that the site was used before 1953 (private communication). Thus there had been an interval of at least six years between the

two nesting periods 1953 and 1959. It is remarkable that the very same trees should be used again; presumably at least some birds must be more than six years old. In many passerines, individuals return to the same area, if not territory, that is used for breeding year after year, but this is evidently not the case with the Wattled Starling. In the last few years in the Eastern Cape breeding colonies have been reported every year (see Appendix 1), but sometimes these are hundreds of miles from the nearest known spot of the previous year. It is not presumed that all nesting sites are known, but several are and these are in areas more or less under regular observation by farmers, so that if the birds bred regularly in one site it would be known. It is inconceivable that the picture presented of breeding in the same site after long periods could maintain the numbers of the starlings sufficiently high for survival of the species. If the same individuals do breed every year it would seem that they breed at some distance from their previous site.

Hitherto, Cock nests or False nests have not been recorded in the literature but observations by J. M. Spence are highly suggestive of this phenomenon. At one feeding area where the birds had returned on several consecutive occasions, about a dozen cockbirds started building nests in the thorn trees. These nests were never completed nor domed, for the cocks would start another nest without finishing the first and thus little clumps of nests were constructed and defended by the cock birds. Females alighted on the bushes but took no activity in nest building. Observations by Plowes and Cusack (1944) may possibly be of this phenomenon. Spence records the nests were built for several weeks.

The true nesting colonies are reported to be established very quickly. Two records indicate that one week there was no sign of nesting and yet a week later nesting was well established. At Boschkraal the nesting area was unoccupied on a Sunday, the following Wednesday nesting was recorded and by Friday both sexes were observed carrying nesting material to the nest. Not only is nesting quickly established, but the entire cycle is rapid. On 28th September no evidence of breeding was seen. On 2nd October the first nesting was seen and by 2nd November only one nest still contained young, a remarkable cycle in which over 400 nests were built, in more than half of which young were reared, all within a period of five weeks. Such a rapid and closely timed cycle also occurs in the Red-billed Quelea (*Quelea quelea*), but this is a very much smaller species. The simultaneous timing of such a large colony of Wattled Starlings is quite extraordinary.

Mention is made above that more than half the nests built are used for rearing young. A second Wattled Starling breeding colony ten miles from Boschkraal with two to three hundred nests was reduced to about fifty nests for rearing chicks. The first point of interest is the building of the extra nests. Many nests are built by birds showing no baldness or pronounced wattling, and it is suggested here that these are birds of the year; the only birds observed taking nesting material from other nests were birds of this group. It is relevant to mention here that in the evenings large numbers of birds would leave the colony and roost some miles away in reed beds. It is possible that these were the same yearling group without eggs or young.

Concerning the reduction in the number of nests, it should be mentioned that nests were actually destroyed by the starlings themselves. This was first observed with the 'yearling' birds taking nesting material from unbuilt nests for their own nests, and later it was found that all the nests on one tree were taken to bits and removed. As these nests were the nearest to the point of observation, the impression was gained that the presence of the observer disturbed the birds, but this was not the explanation for one nest. Eggs were noted in the nest on the 11th November and these had hatched by the 14th. This was a single nest and when the site was inspected on the 20th there were absolutely no signs of even twigs on the ground beneath the tree where the nest had been situated — the whole thing, young and all, had disappeared!

Nesting

In all records for the Eastern Cape the nest sites are situated in thorn trees, which would seem to be normal in Southern Africa, the site varying only in height from the ground, the lowest recorded being just over five feet and the highest was about 20 feet. All were situated in the thorny *Acacia karroo* trees inside the outer foliage amongst the thicker branches.

The nest usually starts with both sexes building a basal structure of twigs. The sides are then built up and finally the dome is completed. Feathers are brought for lining before the dome is commenced and at this stage the eggs are laid. No doubt Sharpe (1884) in reporting that the species built cup-shaped nests had found the colony at this stage of the proceedings. The structure appears rough and untidy from the outside but inside the chamber there are no ends or pieces sticking out. The entrance is usually from the side or from above, sloping slightly downwards in single nests, but in multiple nests the entrances are frequently steeper, some even becoming vertical. One such nest had a vertical tunnel of at least nine inches before the nest chamber. A few nests may be solitary, but the majority were of two or three nests combined in one mass of twigs, and as many as eight in one mass were noted.

The main nesting material observed was sticks from the thorn trees, but stalks from a composite, which in many cases still retained the seedheads, were also used. Within the cavity were a few heads of grass and other plant leaves and seeds, and there were a few feathers lining the bowl, guineafowl feathers being used in one instance. Despite the dirty nesting habits, few nest parasites were found. A few Tropical Fowl Mites, *Macronyssus bursa* (Berlese) were found, also living Psocids and one Dermestid larva.

Building of the nest is shared by both partners. Usually the material used was freshly gathered within sight of the nest. A bird would fly downwards from the nest to land on a low branch, where it would then strut up and down peering at various twigs before deciding upon a particular one. This would be grasped in the bill and then broken off; if it did not come easily it was left and another selected. The bird would then fly back to the nest, uttering a flight call before reaching the nesting tree. Very often the mate remained near the nest preening or resting until the other bird arrived with nesting material and then it too would fly off to gather another twig. In the communal nests it was usual to find one or another of the pair at the nest during the building period. It appears probable that at this stage the eggs were either being laid or had already been laid, which would explain the constant guard by the birds.

Eggs

The eggs are laid before the nest is complete. This assumption is based upon the fact that building was observed to be actively carried on up to about three days before egg shells from hatched eggs were found on the ground. It is also confirmed by Sharpe's (1884) reference mentioned above.

The eggs are white with a pale bluish tinge. "Heaven-blue" to white have been recorded, but all the eggs observed were similar in colour at this colony. Egg shells, which were littered on the ground under the nests after hatching, rapidly lost their delicate blue after the first day or two.

Only four clutches were noted, three of these being of four eggs and one of three. Both sexes incubate. During one period of observation with the temperature abnormally high (88° F. in the shade) no birds were seen to be actually sitting on the eggs.

Nestlings

Hatching occurred almost simultaneously throughout the colony. First egg shells were observed on the 11th (two only) and by the 14th innumerable shells were strewn about the ground. The young are naked and flesh-pink in colour.

Development is rapid and by the 27th the first young were already scrambling over the nests (13-16 day interval). In one nest there were newly hatched young and hatching eggs on the 14th and on 29th one of the young climbed out of the nest when it was approached for inspection. Another nest with newly hatched young on the 14th had the young scrambling on top of the nest on the 29th (15 days old).

When the young are still unable to fly they crawl about the nesting tree and most are found sitting on the tops of the trees calling incessantly for food. Six days after the first young were seen scrambling out of the nest, the number of young in the colony was estimated to have halved, so that the young must leave the nesting colony almost as soon as they can fly. They remain, in the Sundays River Valley, however, for as long at least, as they can be distinguished as young.

Parental Behaviour

From the observations made, it is believed the species is monogamous. Only two birds were ever observed in attendance at one nest and both sexes take active part in nest building, incubation and feeding of young. The degree of activity of either the male or female in relation to the activity of its mate varied considerably; thus in some the males were more active, whilst in others the females were more active.

During nest building the pairs remained in fairly close proximity to each other in the initial stages, even away from the nest, but when the eggs had been laid, one bird always remained at the nest. In a one-and-a-half hour period of observation on one nest, it was unattended for only five minutes; the male was absent for only three intervals (the longest of 10 minutes) and brought twigs twice; the female was absent most of the time and brought twigs on only two of her three visits.

During incubation both parents bring new nesting material to the nest. After young hatch, the males still bring fresh nesting twigs fairly frequently, whilst only one female was seen to do so at this stage of the breeding.

The mode of collecting food for the young varies as the young aged. At first birds collect near the nests carrying out their characteristic straight downward flight from the nest that was evident during nest building. Having settled on the ground they then strut about seeking food, usually covering many yards before having sufficient and flying back to the nest. As the young become larger (and presumably the local food source dried up), the adults fly further afield. They usually depart in small groups, in this case calling and flying across to the orchards especially when irrigation was taking place. Food observed as being carried included grubs, earthworm-like creatures, a moth, antlion, grasshopper and caterpillars.

In the earlier literature there is mention of how the adults leave their young when the food supply fails and the young starve to death. The best description is that given by Mrs. Barber (Cradock), who was evidently a competent observer and there is one recent record by Mr. J. Sneyd Taylor of a similar occurrence. However, there is no doubt some exaggeration and this is more than likely due to the fact that a number of young die in the colony, their remains being quite evident. The whole nesting cycle is so abnormally short that observers return expecting to find young when in actual fact they have already left and all that remains are the evidence of a mortality which is not unreasonable for such a colonial nesting species.

Aggression was observed only once in the nesting colony. One male in possession chased off another bird that landed on a group nest to which it did not belong.

Soliciting was frequently seen. The stance assumed is similar to that of the singing bird. The head is pumped up and down more rapidly and the wings (lowered) are quivered. The tail is inclined upward thus showing the white rump more prominently against the dark tail. The male faced the female, thus standing parallel to the branch, or more frequently, the male would sit alongside the female and sidle up towards her in an excited quiver and chattering

of song. Copulation followed from this pose, usually with active soliciting by the female. After copulation the female would continue to solicit, sometime with the desired effect, but on most occasions the male settled on a branch a short distance away and preened in an exaggerated manner.

On one occasion copulation was observed about five miles away from the nesting colony.

The birds acted in unison when alarmed. On one occasion a raptor flew overhead. The effect was sudden panic with all birds rising into the air and merging into a dense flock which streamed off to the outside of the colony to settle on the topmost branches of a tree, all chattering and craning their necks as though to see what all the alarm was about. As suddenly, silence fell on the group and they all departed as small groups back to their nests.

Summary

The results of observations at a breeding colony of Wattled Starlings are given with discussion comparing previously published information. Comparison is made between the birds of the Eastern Cape Province and elsewhere.

The species is not a regular migrant, but wanders widely. Ecological factors such as association with breeding locusts and feeding habits are given. The wattled condition of both sexes is discussed; sexual dimorphism probably disappears with age. There is a clinal colour variation in the geographical distribution.

Both sexes take part in all breeding activities. False nests and nest destruction is mentioned. The remarkable timing in the breeding results in the colony having a limited existence of only five weeks. Fledgling period is 15 to 16 days.

Acknowledgments

Thanks are gratefully extended to Maj. E. Woolley, on whose farm the colony nested, also for his keen interest, observations, and for keeping the author informed of events.

Mr. J. Sneyd Taylor has very kindly made all his notes available; these include many letters, the results of an inquiry into this species made in 1953. He also collected details on the nest and nest parasites, as well as making field observations. Miss A. Pomeroy also assisted with field observations. Mrs. Schutte kindly gave information on a second breeding colony which nested on her farm at Kirkwood.

Personal communications to J. Sneyd Taylor, C. J. Skead and the writer have been quoted from Messrs. W. F. Quinton, S. H. Rubidge, E. McNaughton, A. P. Bremner, G. Maasdorp, V. Pringle, F. S. Pocock, A. Lea, R. W. Weir, Mrs. C. Niven and Miss M. Paterson. Records of the R.O.S. nest cards have been used.

Appendix 1

Records of nesting in the Eastern Cape reported to J. S. T.

Beaufort West	March 1956; Bred after abundant rains, best since 1921. Previous nesting not known. Wattles recorded January to March. (Quinton.)
Oudtshoorn	Breed irregularly.
Graaff-Reinet	(*a*) 13th January about 60 nests at a site they have been known to use before. (*b*) Also on McNaughton's farm where they do not breed every year—only in good seasons. (*c*) Nest along both sides of road for about 500 yards; new in the area. (Rubidge.)
Bedford	Bred near here three times in last 10 years, also bred at Spring Valley. (Pringle.)
Queenstown	A very large colony 1951. Seemed to coincide with great increase in grasshopper population. Occurred three to four years ago. (Weir.)

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G. J. FOCK, Dr. phil.
McGREGOR MEMORIAL MUSEUM,
KIMBERLEY.

Preliminary Archæological Survey of the Witsand

Apart from the Vaal River area, the North-Western Cape is only very little known from an archaeological point of view. J. P. Johnson (1906) describes implements from various sites in the Herbert, Hay, and Prieska districts, and from the Asbestos Mountains. B. D. Malan excavated the Wonderwerk Cave near Kuruman where Fauresmith, Middle Stone Age and Smithfield were found. From the Koning Native Reserve van Hoepen (1928) reported Smithfield A.

In March, 1959, the present writer had an opportunity of touring the western parts of Griqualand West when he was able to make collections of surface finds from some 60 sites. The most westerly point reached on this tour was the Witsand dunes. The "Witsand", famous for the "roaring sands", is a complex of white dunes on the western side of the Langeberge bordering the Kalahari. The dunes extend for about 5-6 miles in a generally north-east-south-west direction. The average width is about 1.6 miles, the total area thus being about 8 square miles. The white sand of the Witsand dunes is surrounded by red sand from the Kalahari. The western ridges of the dunes show a steep drop of 75 feet to the plain. At the southern end, where the famous "roaring" may best be observed, the dunes are very steep too and a rocky koppie terminates the Witsand.

The north-eastern part of the Witsand has flat dunes partly overlying an old pan. The dunes are separated by relatively broad valleys. They are partly in movement; this may be observed near a windmill at the northern part where a fence is nearly totally covered by sand. But on the whole the dunes are stable. It is generally said that the red and white sands do not mix. But observation of some samples of sand from different sites showed that the white sand contains a certain percentage of grains coated with iron oxide. This phenomenon needs further investigation.

During the recent visit the author was able to collect implements from a number of sites on the Witsand. Usually the visitors to this area are interested in the "roaring sands" at the southern part, which "roar" best during the dry season. Visitors camp near a windmill on the farm Doornaar about half a mile from the homestead. Not far from this camping spot stone implements are to be found predominantly microliths. There is also a family of Coloureds living on the farm who, according to their story, are related to the Rehoboth Basters. This is probably correct as they make "karosses" of goat- and game-skins using the same technique as the Rehoboth Basters in South West. Visitors as well as these Coloureds seem to have collected a large number of microliths and crescents over the years so that these have

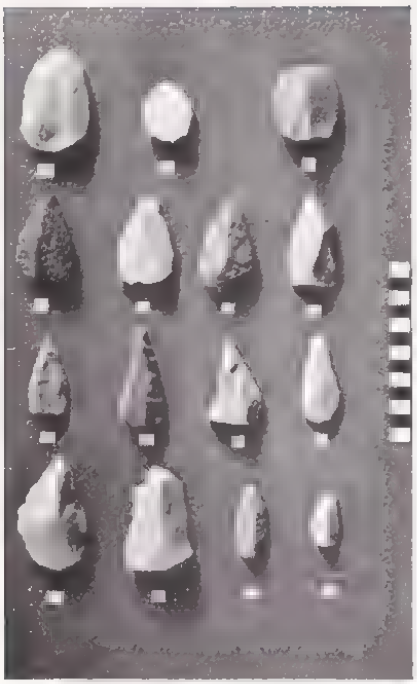


Fig. 1

Fig. 2

Fig. 3

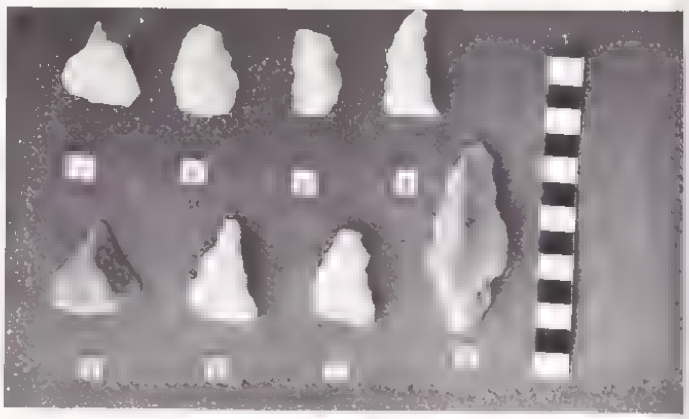


Fig. 4

now become very rare near the camping site. The writer is not aware of any publication on these Witsand implements: they are probably lost to science. The future field-worker must bear in mind that the areas most visited on the Witsand are left with only a selection of artefacts from which crescents and similar artefacts are missing.

Nevertheless the Witsand still abounds in stone implements, mainly far off the roads in the midst of the dunes.

The water-table is not very deep and water is to be found only a few feet below the surface. The supply is quite strong but its source is unknown. Obviously it does not depend on local rainfall for during the last year the water level in the test-hole rose by several inches although only very little rain had fallen in that area and there are some six windmills which pump water for cattle. This water-table is not connected with the groundwater in the surrounding plain (red sand) where the bore-holes and wells are rather deep.

Thus we find plenty of water in the Witsand dunes even in a semi-arid climate. That the dunes must be of a great age is indicated by the large camelthorn trees, possibly up to 350 years old, growing at their foot near the homestead. The water-table in the Kalahari itself is about 290 feet below the surface, the difference in level between the two water surfaces is therefore well over 300 feet. According to van der Walt (1940) the water occurring on the top of the white sand dunes does not seem to be a surface phenomenon but is evidently connected to a subterranean source under high pressure charged with appreciable amounts of lime in solution. This dissolved lime, together with the iron compounds cementing the sand grains, thus builds up an impervious funnel-shaped ring by which the water is prevented from draining away into the loose sand. Where the water can rise in this way to moisten the surface layer, wind-blown material will naturally accumulate.

In the north-eastern part of the Witsand the writer collected 385 implements and artefacts from the surface between the dunes and at their feet. This site is not far from an old pan. (See map after *S.A. Geographical Journal*, Vol. XIX, December 1936, Lewis). The collection comprises two different cultures: Middle Stone Age and Wilton. The implements are made of greyish quartzite and milky quartz, and a few of chert. The quartzite implements are very wind-worn and show a desert glaze.

(1) The **Cores** are Levallois disc-cores. The largest has a diameter of 9.5 cm.

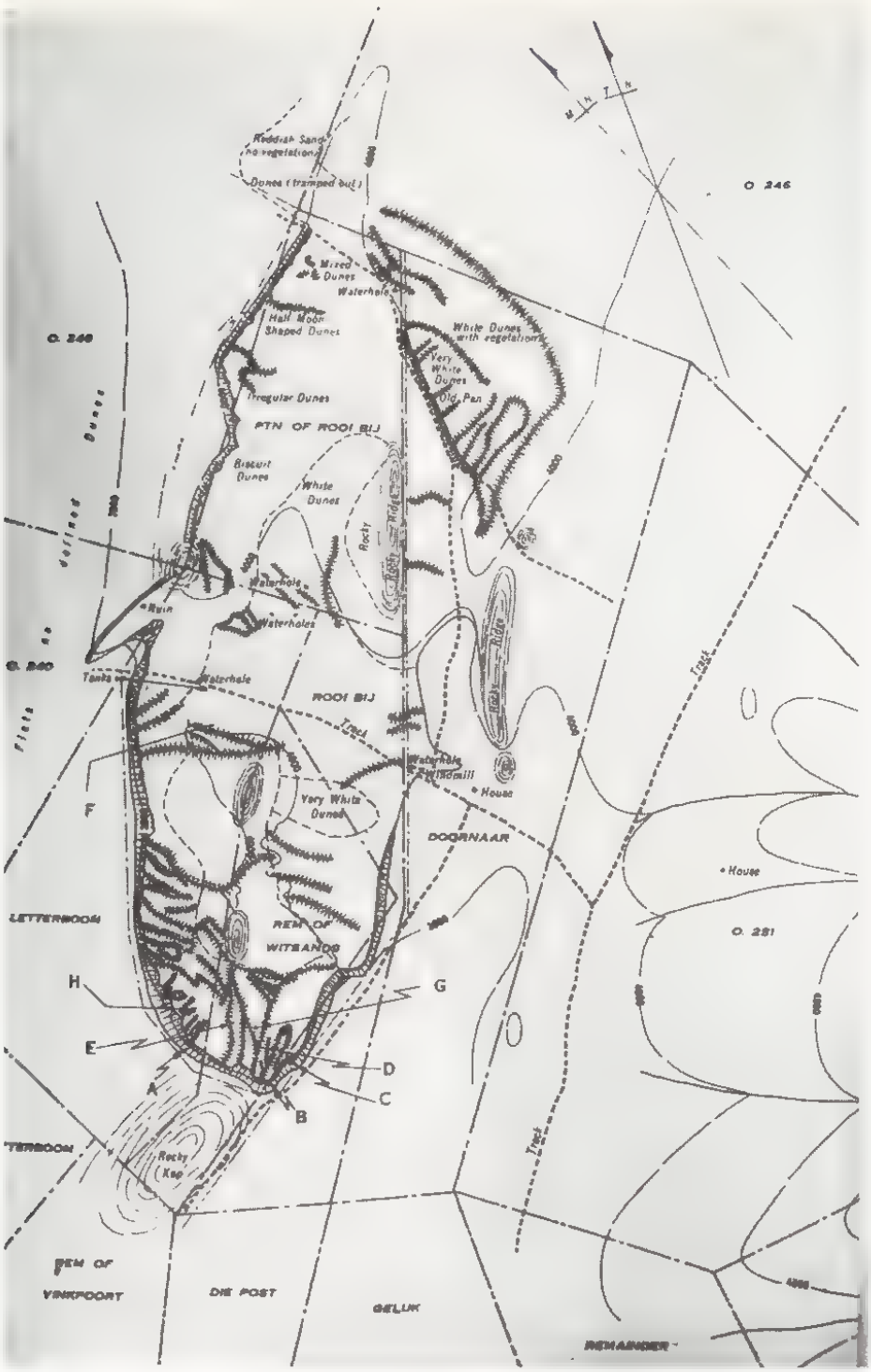
(2) **Points.** Some points with convergent flaking show no secondary trimming after they had been struck from the core. The butt end is faceted. The main feature of these points is their breadth, the broadest, which is broken, measuring 4.4 cm. (fig. 1).

(3) **Trimmed Points.** There are a few slender flakes with faceted platform (fig. 1). They show secondary trimming on their dorsal face only. The trimming is along both edges or along one edge only. One implement shows a reduction of the bulb. There is one point with a high keel on the upper face of the point end. One edge shows a secondary trimming with alternating blows giving a serrated edge. The measurements of this implement are: length 8.6 cm., width 4.9 cm., thickness 2.5 cm. The lower end of the dorsal face is trimmed, the secondary working is shallow (figs. 11, 3).

The other implements include flakes with straight striking platforms. One of these (11 cm. long, 6.8 cm. broad) shows a crude backing along one edge: other flakes have serrated edges.

A second group of implements is made of milky quartz (fig. 4). Among these we find borers, a backed blade and other implements with faceted platforms, though rather high-backed with a steep secondary trimming, and thin sidescrapers.

Another Witsand site was found nearby in the midst of dunes near a pool of open water. Here the dunes are high with the valleys between some 20 yards wide. The implements found in these valleys are of quartz and some are very wind-worn. They comprise small flakes (2.3 cm. long, 0.9 cm. broad and 0.3 cm. thick) showing no secondary trimming, microlithic



Witsand after Lewis, 1956

burins, small points (1.2 cm. long, 0.8 cm. broad at the base), a few crescents and one core. The crescents are very rare for the reasons mentioned above. This assemblage is a typical Wilton site with many rejects, indicating that the implements were made at this spot.

At this locality, however, some other implements of quartzite which are not Wilton were also found. Among them are: one clumsy backed blade (fig. 4, 8) 7.8 cm. long, 3.3 cm. wide, 1.7 cm. thick, and two cores. Unfortunately this assemblage is too small and undefined to provide clear evidence but I suspect traces of Magosian influence here.

About half a mile distant from the camping site there is another Wilton site, situated on a shallow fixed dune on the border of the main dune area. The collection consists of horseshoe scrapers, thumbnail scrapers, crescents, cores, borers, small points and tiny flakes; some ostrich egg shells and pottery sherds were also recovered.

The southern end of the Witsand between the "roaring sands" and the rocky koppie produced a similar assemblage of Wilton implements and some cores, the latter probably of Middle Stone Age. One of these cores had been used as a chopper.

As mentioned before the Basters are collecting crescents and I obtained a rather good collection from them. The individual localities from whence these come are unknown, but I was assured that they all come from the central part of the Witsand complex. It is worthy of note that among this collection of 60 microliths there is not one double crescent.

To sum up the following may be stated. The area to which only a flying visit was paid seems to be worth a thorough study. At the moment there is not enough material available to permit a comprehensive account. So much, however, can be said. The Witsand has been inhabited since at least Middle Stone Age times. Sites on both the northern and southern parts yielded Middle Stone Age and Wilton implements. The water-table of the Witsand must therefore have been accessible during at least the past 20,000 years. Even during the period following Middle Stone Age this water-table must have been constant enabling Magosian people to live here at the fringe of the Kalahari. It was an ideal site for Wilton people. The ones living here differed from their cousins in the Cape in so far as they used single crescents only instead of both single and double ones.

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M. de LANGE, B.A.
EAST LONDON MUSEUM.

Dolls for the promotion of fertility as used by some of the Nguni tribes and the Basuto

Working through the Ethnological specimens at the East London Museum, I was particularly intrigued by the collection of symbolic dolls, indicative of the little known customs of the tribal woman. It would be interesting to know how general these practices are among the tribes of Southern Africa. Unfortunately these dolls are not easily procurable the women setting great store by them and unwilling even to sell them. Only the specimens in the East London Museum will be described.

I could find no references to certain types of fertility dolls in any of the books I consulted, and much of my information derives from descendants of old settler families who specialized in the ethnological material of that time. Also I found on enquiry that the old Bantu women still adhere to and religiously believe in the old customs. One reported to me thus "All these dolls are for the same thing and are called *onomgogwane*. When a little girl plays with ordinary dolls (*onopopu*) all the time, her mother knows it means she will have a large family. But as she grows up she cannot play with these dolls any longer, and the old woman makes her a special little doll (*Nomgogwane*) which she wears round her neck so that she will get married and have lots of children and good luck. This she wears until she is about to be married. A big doll is then made for her to carry in her arms and nurse, so that she will have lots of children". An old Galecka woman told me of the dolls, and her story was confirmed by an old Xhosa woman.

The keeping and making of symbolic dolls is a tradition conceived, organised, and perpetuated by the womenfolk alone, and reveals the dearest desires of a woman's heart since her advent upon the earth –to find a man who will love her, and to have children. This most primitive attempt to control nature, which is synonymous with sympathetic magic, has been perpetuated among the S.A. Bantu, but today these customs are almost obsolete.

Not all the tribes use the same means of ensuring many children, but all have one custom or another for this important function. The great importance of child-bearing is owing to the Bantu social system, where marriage is a contract between clans, so that the great thing is not the wife, but her reproductive capacity. A wife's social status is only acknowledged once she has children (13). In this paper three kinds of symbolic dolls are examined, all of which typify the primitive woman's rites. They are:

Love-Dolls,
Fertility Dolls, or Bride Dolls,

Fig. 1

Fig. 2

Fig. 3

Fig. 4

Calling-the-baby Dolls, or Hut Dolls,
and will be described respectively. I shall treat them in the order of their supposed magical influence on the lives of the Bantu women.

Love-Dolls

The young girl's dolls are not often made nowadays. As is the case with so many superstitious rites, this practice has all but died out. These are the little dolls which young girls wear around their necks, which could be called "love-dolls", as their first function is to attract a husband, though with the object of having children. "Their national customs appertaining to marriage also assist them towards attaining motherhood" (10). One of our specimens was collected in Basutoland, the other two are Xhosa, one being made by a Xhosa woman who was one of Kreli's people. It seems to be a Xhosa custom.

Among the Bantu tribes a spinster is seldom heard of. This fact is largely due to polygamy, whereby a man may take to wife as many women as he can "lobola" or pay for, in as far as it is politic. For a man who takes many wives awakes envy, and is suspected of setting himself up as a rival to the chief in wealth, many wives signifying to the tribesmen many cattle, hence wealth (5, 6). But there is not "a single man in Kaffirland who does not hope and believe that he will live to marry three or four wives" (7). If a girl is not sought in marriage, her parents look for a son-in-law (4) or they may even present their daughter to a man already possessing wives, an offer which out of politeness he cannot refuse. In such a case the *ikhazi* (bride-price) received is below the normal value (10). A woman may divorce her husband or run away, but pressure is always put on her to return to him. Thus there are few if any spinsters in the tribe. But the girls always hope to be sought in marriage, as this is the most respectable path to marriage (4). They wear a love-doll as a lucky talisman to ensure success in the form of an eligible husband and plenty of children. A woman's prestige lies mainly in the wealth of her husband and the number of her children.

If a young woman of 18 or 20 or even older, through misfortune has not succeeded in marriage, an old woman will give her a doll which the girl is then supposed to hang around her neck when she sleeps at night, or wear beneath her clothing. A string of beads is often specially made attached to the doll so that it can be used as a necklace. Girls are encouraged to wear these doll necklaces by the older women, in the belief that it encourages productivity, but if her main reason for wearing the charm is to find a husband, some degree of secrecy is in operation. It would be a matter for shame were it discovered that she was looking for a husband (4). It is a reproach among women to be told "You were spied for" meaning that your people searched for a husband for you, you were not sought in marriage (4). A bride is not supposed to marry willingly, a convention which is perpetuated in the wedding ceremony of some Nguni tribes where at one stage in the proceedings convention demands that she should try to run away. This unwillingness is as much a convention among the Bantu as the "radiantly smiling" brides of our civilisation.

Similar necklaces were seen in use about 10 years ago by young women at an *Intonjane* (girls' initiation) dance, not by the young *Intonjane* girls themselves, but by the marriageable girls (*amantombazana*). These are the older girls who had cut their hair and given away their old clothes when the older boys became *abakhwetha*. They now wear calf-length skirts and adopt a more elaborate doek. The clothing of the women, particularly the style of their head-dress, indicates their status.

The *Intonjane* is a young girl who is entering puberty, and is thus secluded for a period of several weeks. This is not a period of instruction, but various sacrifices are made for her. If a married woman did not have something killed for her, and ignored the custom prescribed for her entry into womanhood, her family has offended the ancestor spirits, and should she prove barren or fall sick, the witchdoctor (*iggira*) will advise her to go back to her father's

Fig. 5

Fig. 6

Fig. 7

Fig. 8

household and undergo the ceremony. This custom is believed to prepare a young woman for motherhood. Thus this is not so much an initiation rite as a fertility rite, for not all women become *intonjane* at puberty, although that is the proper time for the ceremony. This is the ancient Nguni fertility rite and established custom; the practise of having a doll may be a recent accretion for it has no effect on tribal life and was not noted by early writers.

Only certain Xhosa tribes have adopted the custom of Bride-Dolls, which is in reality a Basuto custom, entrenched in their tribal life and noted by European visitors. An interesting Fertility Doll is fig .6 which is probably Thembu. The doll is similar to the Basuto dolls in conception, but is attached to a necklace, after the Nguni fashion.

The Love-Dolls at the East London Museum are all covered with beads, the oldest one dating back to 1907. If these dolls represent a comparatively late custom (a suggestion of the Bantu I queried) it leads to much speculation. The custom is certainly a symptom of sympathetic magic, and perhaps the idea was adapted from the Bride dolls of the Basuto. (By the end of the eighteenth century Sotho-Tswana tribes were occupying Basutoland, and some Basuto had infiltrated into the Griqualand East area, probably about the middle of the nineteenth century (1, 15). The idea is certainly an ancient one. However, it has been observed by modern ethnologists who have studied the urbanized natives in the locations (4) that old superstitious ideas are conveyed to town and forced into service for new needs under new conditions. Could it be that as young men left for European employment, sometimes for long periods, and as economic considerations (4) stultified polygamy, more young girls found themselves in danger of being left on the shelf? I find no reference to this custom among early writers. The tradition of "bead dolls" seems to be established. Were they ever made of any other material? Do they definitely post-date the introduction of glass beads into South Africa, and that, when a copious supply of regular European beads were available, probably since the eighteenth century? The beads used in the East London Museum specimens are for the most part tiny glass beads of vivid colour which are bought at trading stores, and are much in favour for beadwork because of their regular size. Within the last 50 years or so, the fashion in beads has changed Formally the beads used were larger and coarser, about 4 mm. in diameter, while the ones used nowadays are small, 2 mm. in diameter. The latter variety has been used in the manufacture of these dolls.

These love-dolls take various forms. Sometimes there are two dolls together, representing a man and a woman, instead of a single doll. The dolls may be merely symbols of human beings, so abstract as to to be almost unrecognisable. Others are so carefully made that they are marvels of nimble fingerwork and detail and are true masterpieces in beadwork. It is a fact that sometimes a single doll is worn, while other necklaces have two dolls, evidently not supposed to represent two babies, but rather a man and a girl. I base my assumption on specimen 1365 (fig. 3) which was given to a young girl by an old Xhosa woman in order that she might find a husband. The dolls worn openly were the single ones. The double ones seem quite clearly meant to bring a man and a woman together. Specimen 1750 (fig. 2) is another double one, and so abstract that were it seen, it would hardly be suspected of representing a man and a woman. This endorses the story that these dolls were kept secret. The custom of the love-dolls seems to have a double purpose, and the stress laid on one or the other, determines the form the charm takes. Basically the charm is a good-luck talisman to bring the wearer "Health, Wealth and Happiness", condensed in Bantu opinion into one word "children".

The lack of information on this custom is probably due to the secretive nature thereof, and the fact that it is not a regularly repeated rite practised by the whole tribe. The fact that it is practised at individual whim, induces one to believe that it is a recent custom, without the full sanction of the tribe.

Specimen 1764 (fig. 1) was made in 1912 and consists of a roll of kaffir sheeting sewn

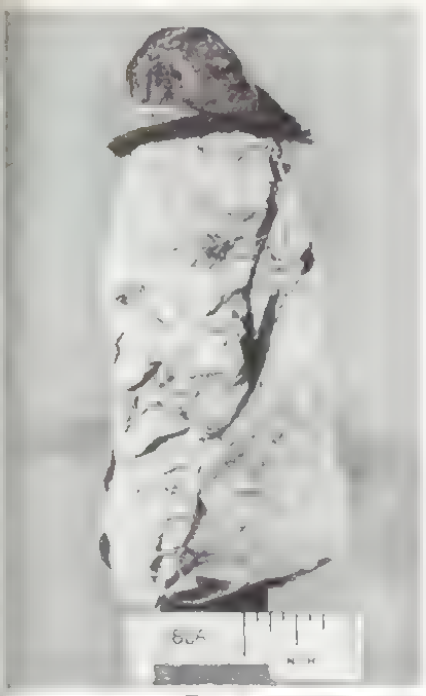

Fig. 9

Fig. 10

Fig. 11

Fig.12

into a cylindrical shape. This is covered from the top almost to the bottom with beadwork coloured in barberpole fashion in strips of green and white, with between them a line of red, black, or yellow beads. Below this beadwork bodice hang streamers of blue beads, in pairs, tipped with green and white beads. On top of the beaded cylinder is a cloth knob, covered over with black velvet to form the head, and each eye is a tiny black bead sewn on top of a large white one. From each side of the neck emanates a double string of beads of alternate lengths of blue, white, and green beads with some black and white beads. One strand of this necklace is $6\frac{1}{4}$ inches long, the other one is $10\frac{3}{8}$ inches long, the short one finishing off in a pearly button, the other in a bead loop, this serving as a fastener which is rather to one side of the necklace. The doll is almost totally stylized except for the head. This specimen was collected by Mrs. I. J. Church, a missionary.

Length of body	2 in.
Length of bead skirt	$1\frac{1}{2}$ in.
Length of bead bodice	$1\frac{3}{4}$ in.
Length of left-hand strand	$10\frac{3}{8}$ in.
Length of right-hand strand	$6\frac{1}{4}$ in.
Total length of doll	$3\frac{7}{8}$ in.
Total length of necklace	$11\frac{3}{4}$ in.

Specimen 1750 (fig. 2), made in Basutoland in 1907 and collected by Mrs. I. J. Church, is wholly abstract in conception. The necklace itself consists of double strands of beads emanating from the upper sides of the pendant, and are of black and white beads with in parts, an admixture of pink beads. The pendant is a symbol of two people, a man and a woman. Two little cylinders of beadwork are made by twisting strings of black and white beads round and round each cylindrical core, each having green barberpole lines. They are joined at the top by a big flat black bead. There is a touch of pink in one doll. The cylinders are joined midway by a red bead. The tops of the cylinders under the flat black bead are covered with knobs of white and black beads, and hanging down from the top of each of these knobs are three strands of black and white beads, tipped with a green bead. Underneath each cylinder "bodice" is a big flat black bead, then a mass of blue ones and another flat black bead, forming a waist. Below the "waist" flare out many streamers of black and white beads with pink bead tips, which represent skirts. These symbols of humans are to all intents and purposes identical.

Length of necklace	$11\frac{3}{4}$ in.
Length of coiled body	$1\frac{1}{4}$ in.
Length of hair	1 in.
Length of skirt	$2\frac{1}{4}$ in.
Total length of necklace	15 in.
Total length of dolls	4 in.

Specimen 1365 (fig. 3) was made in recent years by a Xhosa woman for an unmarried girl and was collected by Mrs. W. F. Courtenay-Latimer. The two dolls are distinguishable as a man and a woman by the clothes they are wearing. They are joined by a pearly button behind, and are suspended on a small double loop of white beads, each end being attached to a figure by a button and bead-loop fastening at the back of the heads. Strands of beads also run from these buttons to the shoulders to secure them firmly together. The dolls are made out of wood covered with beadwork, and are similar in shape. The bodies are flat, shape being given by notches for a neck and a waist, and they have stick legs. The legs are not all in one with the body, but are firmly sewn onto the wooden body, thus are somewhat movable, particularly the woman's. As is usual, neither have arms. Both figures are completely covered with beadwork, white beads being used with black ones to mark the features of the face (hair, eyes, nose, mouth and ears) and for decorative lines and patterns on the bodies. The

heads are cloth knobs skilfully fixed onto the wooden bodies and covered with beadwork continuous with the beadwork on the bodies. From the woman's ears hang fine copper wire hoops as earrings. There is a black design on each chest; a black diamond shape with two white dots on the man, and a black hourglass shape on the woman, who is decorated similarly back and front. There are black lines and a diamond shape below the waist of the man, and a symbolic woman figure below the waist of the woman. (This woman figure is similar in style to figures found on a certain type of necklace used by Xhosa men. The native wearers say that these figures represent their wife or wives. Certain ways of representing the arms, legs or bodies, denote characteristics such as laziness, shrewishness, love of amusement, etc.) The woman's legs have bands of blue and black at the ankles and of pink and black at her knees. The man has one pink and black and one blue and black anklet, and has a blue and black parallelogram design on one leg. Both figures are hung around with bead necklaces and have skirts and other ornaments typical of their sex. Each figure has ornaments, probably denoting the many beaded cloth bags which men and women are fond of hanging about their persons, slung over their hips. These are blue straps of beads that emanate from the middle of their chests and backs, with short streamers hanging from the strap, white with blue and black touches. The woman has one such "sling-bag", the man has three, one with blue beads, the others just black and white. Around his waist the man wears a beadwork band, white with a black fleck design, from which hang short bead threads touched with blue to form a skirt probably intended to be an *umthika*, a sort of skirt of tails. At the open side is a pearly button from which a long tassel of white with black beads, each strand of which is tipped with a little tassel, falls to his feet. In all his bead finery he is a great gallant. The woman has a short blue fringe in the v-style, tipped with big black beads around the bottom of her beadwork body, which indicates she is wearing a skirt. The short skirt, as against an *inciyo* (thread apron) or a full-length skirt, shows her to be between childhood and adult status –in fact she is an *intombi*, a girl of marriageable age. She also has a waistband of black and white beads with small sections of the blue v-style fringe at each side of it, and a black and white bag ornament emanating from her waist.

Length of bead loop	3 in.
Length of woman doll	$4\frac{3}{4}$ in.
Length of man doll	$5\frac{1}{8}$ in.
Length of woman's legs	1 in.
Length of man's legs	$1\frac{1}{8}$ in.
Length of man's streamer necklace ..	$3\frac{1}{8}$ in.
Length of the bags	$\frac{7}{8}$ in.
Length of man's tassel	$2\frac{1}{8}$ in.
Total length of dolls with loops ..	$7\frac{5}{8}$ in.

Bride Dolls

Like all Bantu nations the Basuto are extremely anxious to have children, and as they are considered in the light of wealth, the girls especially, they want as many as possible. A childless marriage is not considered a binding one and barrenness is considered as a great disgrace, thus the women are particularly anxious to have children (2). All Eastern Bantu tribes have some precautions which are supposed to ensure fertility; the seclusion of Xhosa and Pondo girls is an example. The Basuto women, when their marriage is imminent, are given a doll which symbolizes a baby. This custom, once universal among the Basuto, is now dying out, although I am told by Xhosa women that the custom is now occasionally practised by Xhosa and Fingo. This custom was noted by missionaries as early as 1833 when the Rev. E. Casalis evidently knew of the existence of this practise (2). However, he gives no description of it in his book on the Basuto. Now according to Casalis, before he

entered Basutoland with his co-missionaries, "none of the travellers who had been led by views of evangelisation or commerce beyond the Orange River, had deviated from the route marked out by the Rev. I Campbell" towards Bechuanaland, and Basutoland had never been visited by the white man (2). Thus we cannot expect reference to the Basuto's fertility dolls to precede 1833, and by 1923 the custom was already rare (1). Reference to this custom is rather fragmentary and conflicting in different reports of its existence, made when its popularity was already on the wane, and my explanation is augmented by accounts of Bantu women of today, and of reports made, though never set to paper, at the turn of the century. It was stated that a doll was made for a forthcoming wedding by the bride's grandmother or some other old woman of the kraal, and that at her wedding she carried this doll, showing that she wished to present her husband with children. The doll is thenceforth kept by the bride as her most precious possession until such time as she is blessed with a child. To lose the doll is a very bad omen. If, however, a child is not soon forthcoming, more cajoling of the Spirit of Maternity is necessary. This spirit is supposed to dwell in a swamp at Butha-Buthe (3).

> "At Butha-Buthe, in the North, there is a piece of swampy ground which, to the ordinary observer, merely looks like a good place for ducks and frogs, yet, to the native inhabitants of the district, it is more or less sacred ground, as one spot there is inhabited by a spirit Some years ago, without any apparent reason, smoke was seen issuing from this "Khapong", as it is called. Consequently it came to be regarded as a spot sacred to the Spirit of Maternity, and hither, from time to time, come old and young with offerings of beadwork, money, food, dolls, etc., hoping thus to propitiate the spirit within, and to receive a favourable answer to their prayers. Women who have no children firmly believe this spirit is able to grant their heart's desire if only they can find favour in his sight. In order that he may see how earnestly they desire a child, they will make either a wooden or clay doll, which they strap on their backs and carry about with them, as they would a living child, for at least six months. At the end of that time, they lay it in the "Khapong" as an offering to the spirit, together with any bangles, beads, or ornaments, or even money, which they can collect. Should no child be born, it is a sign that the woman has not found favour with the spirit yet, so the doll is removed from the "Kaphong" and strapped on the woman's back until the spirit is satisfied, when oh, joy! the longed-for child is born. I know of one case where for five years the woman carried one of these dolls about with her before her petition was granted."

This report was made about 1903. While they kept their dolls with them there was another ritual which they performed:

> "Every means is taken to bring about the desired event, and this necessitates many visits to the medicine man. What is more, among the lares and penates of every Basuto family there used to be kept a crude doll, and when there were three or four of these despairing women round about, they would come together with their dolls to implore the controller of their destinies to come to their aid, and, hearts on lips sing the 'Song of the Childless Woman'. 'These dolls we nurse in our arms', they cry, 'have lips, but speak not; ears, and hear not; eyes, and see not; and when they lie next us in our blankets at night there is no warmth that answers to the warmth of our bodies. Have pity on our unhappy state. What is the use of a lifeless lump like this? Give us a real child, give us one that speaks, that hears, that sees; one that lies warm to our breasts.' At length they cease their prayers, and their pleading cries give way to strident curses." (1).

The woman sleeps with the doll and never leaves it. The doll is given a name, and should a child arrive, it will be called after the doll (12). When the woman does eventually give birth to a baby the doll is put away with her other possessions, and is often kept as a toy for the child, or otherwise she gives it to children of the *umzi* (homestead) to play with. She

does not depend on a doll for further children, and once she has had a baby the doll has no magical purpose. This was told me by a non-Basuto native, and it is possible that the Basuto woman would keep the doll for the use of her daughter. Thus fig. 8 was still in use in 1943, although the beads seem to suggest that it was made long before.

The fertility or bride-dolls evidently did not always represent a baby. Instead they merely represent a person; sometimes they are just pretty dolls covered with brightly coloured beads, sometimes they are dressed in clothes of traditional style. Some are dressed like boys, some like girls. Of our specimens, four are wearing girls' costume, one is wearing boys' clothes. Among the Basutos, girls were more desired than boys (3) as a girl meant future wealth to the family. All symbolise babies. Our oldest doll represents a bride, being the most detailed in conception and recognisably following a custom in its form of dress. However, it may be that the fertility doll never did take a traditional dress. Specimen 2806, fig. 9, is dressed in a long skin cloak reminiscent of an *Abakhwetha* (boy initiate). The other two older specimens, belonging to the turn of the century, are dressed in no recognisable customary style, and in specimens 2266 and 2355 (figs. 10, 11) one collected as late as 1955, European ideas have without doubt deeply influenced the make of the dolls, which are made on similar principles to European toys. The beads used in the make of these dolls are generally of modern European type. Small opaque beads of about 2 mm. diameter are used in the beadwork covering with slightly larger ones (4 mm. diameter) appearing in the trimmings. Similar tiny transparent beads are used in fig. 7.

Fig. 8 presents some very interesting beads. The large beads, pendant from the fur covering, are wound-type opaque beads, of colours ranging from sky blue, to pale blue, turquoise, and a blueish-green. They are very irregular in size and shape, having a diameter of 7-10 mm., and appearing as globular, somewhat annular, or elliptical verging on cylindrical. Two are double beads, the beads being complete in themselves but still joined, thus having a common perforation. These beads seem old, and are possibly of a type imported by the African Lakes Corporation, and used for barter (11). Many are worn and crusted over with a sediment which cannot be scratched off without causing the bead to crumble. Many of the beads are streaky in colour, and some cracked. The perforation is regular, not tapering as have the wound-technique beads made in India and so extensively used by the Arabs in slave trading along the East African Coast. They are probably of European manufacture, either Venetian or German. One small red bead is threaded at the end of the strand at the left of fig. 8. This bead has an opaque white core with translucent red surface, and was probably imported from Europe at the end of the nineteenth century. The brass beads around the collar are probably made by the Bantu (6). Fig. 8 was probably made long before 1943 when it was collected, perhaps about 1900.

Specimen 154 *A* (fig. 4), was made about 1900, mainly out of wood. It is very carefully made to represent a bride in full dress. The body is a slightly tapering log of wood. The head is somewhat rounded. At the base of the neck is carved a peg, which fits into the wooden body. The doll once had a face modelled out of clay, which has dropped off. Remnants of clay fill in the angle between shoulder and neck, and once covered all the wood surfaces, as is shown by scraps of clay on the body. The back of the head is till encrusted with clay into which has been pressed beads threaded together, to form the hair. The back part is of dark blue beads and the front part is of black beads, while a double row of white beads arches over the brow at the edge of the black part, evidently a white chaplet. The wood surfaces are quite smooth, having been shaved by a knife, and are rubbed with red ochre. There is only one ear remaining and this is formed by a blob of clay. The ear is pierced and carries a white bead earring threaded on sinew. The beadwork skirt is worked from top to bottom, with the exception of the rows of beads forming the waistband, and has a cloth backing. It is edged with larger white beads at the bottom. The motifs on the skirt are variations of an

old Basuto symbol a square with a small square at each corner. This symbol is represented in various forms of rectangles, some bearing two tiny corner-squares. They are worked in traditional Basuto bridal colours red, orange, blue, yellow and black on a white background. A black and yellow band appears about halfway down the skirt. A coiled wire circlet surrounds the bottom edge. The necklaces and earring are very interesting, being very similar to specimens in the East London Museum which were actually worn by Basuto brides. There are two types of necklace—a bead type, and a grass type which takes two forms. The bead type has a fancy bead in the centre—in this case an elliptical etched blue one with emanating from each side, three strings of white beads variegated by coloured ones at intervals. Of the grass necklaces, the one around the neck and the centre pendant one are made by coiling grass round a circular grass core, and are decorated with bands of beads at intervals, of white and some coloured beads. The other two necklaces sewn onto the grass neck-ring are hoops of plaited grass. A length of plaited grass is looped several times, and held intact by bands of white beads interspersed with a few coloured beads. The coloured beads are always either red, orange, yellow, blue or black. A single hoop of beads of these colours and white beads, is suspended on a necklace of tiny blue transparent beads. This doll was presented to Mrs. E. Ashburner by a Basuto woman whom she nursed with her first baby. This woman had previously lost several babies, and in gratitude to her nurse she presented her with the doll.

Length of body	$10\frac{3}{8}$ in.
Diameter at base	$3\frac{3}{4}$ in.
Diameter at shoulders	$2\frac{5}{8}$ in.
Length of head	$2\frac{3}{4}$ in.
Width of head	2 in.
Length of earring	$\frac{5}{8}$ in.
Length of skirt	$8\frac{1}{4}$ in.
Length of uncovered body	$1\frac{5}{8}$ in.
Total height of doll	13 in.

Specimen 1140 (fig. 5) is also Basuto, and was made about 1909. It is made out of clay a cylindrical body with the base hollowed out like a basin, and tapering slightly to the neck. The head and the face are modelled slightly to indicate a nose and ears. The whole specimen is covered with beads, wound round and round the figure on a cloth backing. From the base to the neck the beading in strings has sections of white and of black beads with red "dots" between; the face is worked in red beads, the back of the head and neck in black beads and the top of the head in a black and white bead mixture worked from back to front. Strands of beads $2\frac{1}{2}$ in. long hang down from the crown to the shoulders, half black and half pink or white or orange—a kind of headdress fashionable at present among the Ciskei tribes. At the crown the "headdress" stands upright in a tiara of black bead loops. Short little arms made of cloth wound around with black and white beads, are sewn on near the neck, the hands being worked from back to front. The windings of beads have been disturbed, showing tatters of cloth through the beadwork. The nose and ears protrude slightly and are visible between the rows of beads, otherwise features are blurred by the beadwork. The doll was collected at Ladybrand by Mrs. W. F. Courtenay-Latimer.

Diameter of body	$2\frac{1}{4}$ in.
Diameter of neck	$1\frac{3}{8}$ in.
Length of head	$1\frac{5}{8}$ in.
Length of hair	$2\frac{1}{2}$ in.
Length of arms	2 in.
Height of doll	7 in.

Specimen 3206 (fig. 6) was presented by Mr. and Mrs. V. E. Deary, who procured it

about 1909 from Molteno. Most probably it is Thembu showing some influence from the Basuto in the North. The doll is made of Kaffir Sheeting, completely covered with beadwork with the exception of the head. The shape of the doll is that of a slightly conical cylinder, stuffed, probably with straw or cloth. The wider base of the doll has several rows of large pink and white beads wound around it in such a way that two rows are underneath the doll, holding the base somewhat away from the ground. The cloth of the base is studded with tiny white beads, a thread being sewn in and out of the cloth, each outside stitch holding a bead, forming a spiral to the centre marked by a red bead. The tapering body is covered from the base to the neck of the doll with beautifully executed beadwork, consisting of red, blue, black and yellow triangles in a design resembling a patchwork of triangles fitted one against another, the horizontal borders between patches being divided by borders of white beads. Dispersed in the coloured triangles are a few white beads, resembling spots. This design is very regular. Around the neck is a cluster of white beads sewn on to the edge of the beadwork covering, forming a ruff around the neck. There is above this ruff a single row of beads white and blue beads threaded alternately with, in front, four larger faceted beads, iridescent, threaded between some tiny red beads. The head, also of stuffed kaffir sheeting, brown with usage, or perhaps stained with ochre, is sewn onto the body, and is spherical. An area somewhat greater than a semi-circle is marked off by a border of white beads, as the face. There are two small white beads sewn to the face as the eyes. Over the rest of the head, at back and sides, are sewn black beads at short intervals apart to represent hair. Issuing from points at the front and back of the doll are the two strands of the necklace. The strand issuing from the front is $8\frac{3}{4}$ in. long and consists of three strings, joining on to a strip of open beadwork, at the end of which is a large loop also done in a delicate beadwork style in white beads, and continuous from the strip. The three strings are similar, having the top inch yellow, then about one inch blue and black, next a red strip, then a shorter black strip, each section divided by white beads. The strand issuing from the back is not similar in colour. The three strands are 23 in. long, joined midway by one large white bead. Two strands leading from this big bead have broken. Beads are in successive sections of white, red, white and blue. In between each section are three beads, either black and yellow or red and yellow. At the extremity is a very large yellow clear glass bead, faceted, about $\frac{1}{2}$ in. long, which served as a button to fasten the necklace around the girl's neck. Also sewn onto the ruff at the back is a double bead loop $3\frac{7}{8}$ in. long for carrying. A big pink bead sewn on at the ruff has two similar loops of beads issuing from it, i.e. red on one side, white on the other with some mixed beads between each section.

Overall height	$6\frac{1}{4}$ in.
Length of body	$5\frac{1}{2}$ in.
Greatest diameter of body	$2\frac{1}{8}$ in.
Diameter of head	1 in.
Width of neck	1 in.

Specimen 2355 (fig. 7) is a Basuto fertility doll, which shows some European influence, though still wearing native dress. It is a rag doll, made of black stocking, and adopts a sitting position, with its legs straight out in front of it. The doll represents a little girl, much like a European toy. The legs and arms are given shape by the amount of stuffing in them, helped by a couple of stitches catching in the arms at the elbow. Hands and feet are formed by a cotton thread wound around the stuffed limbs. Toes and fingers are neatly worked by cotton oversewing stitches. The arms are sewn on to the sturdy body. The head is separated from the shoulders by a cotton thread wound around the stuffing to form a neck. A red embroidered mouth, a bump of a nose formed by a lucky bean under the cloth, and two big eyes made of white cloth-covered buttons with a big black shoe button on top, form the features of the face. One brass ring earring is still sewn to the side of the head. The doll wears a hat woven

from grass in a European sunhat fashion, with an orange embroidery cotton cord sewn around the crown, and a little skirt woven in a similar way from grass. A string of multicoloured beads is threaded round the neck, both arms and both legs. Also around the neck are two wire circlets, both of coiled wire, one with brass bands clamped around it at intervals. Multicoloured beads threaded on a wire, with a large yellow bead in front, form another necklace. It was donated to the Museum as a fertility doll by Mrs. I. J. Gibbs in 1955, but it was collected about 1925 when her husband was resident Magistrate in Basutoland.

Length of legs	$4\frac{1}{8}$ in.
Length of arms	3 in.
Width of head	$2\frac{1}{8}$ in.
Height	$7\frac{1}{8}$ in.

Specimen 2807 (fig. 8) was collected by Dr. J. Denfield at Quthing in Basutoland in 1943. The body is cylindrical, tapering slightly from the base to the neck, the clay being sloped backwards to form the head, with no break between the neck and chin. The face is roughly shaped, in fact misshapen. A hole is the mouth, two little holes are the nostrils, and against each side of the little bump in front which forms the nose is a lucky bean eye pressed into the clay. In the front of the head are two little flaps of clay with a hole in each, which are presumably the ears. On the top of the head is the hair, represented by light blue beads stuck into the clay. A tassel of red-ochred threads hangs from the crown to the neck. The head is stained with red ochre, and the body is sewn up with sinew thread into a piece of skin. In front, covering this like an apron, is sewn a piece of furry pelt, on a band of skin which is wrapped around the body and sewn firmly in place. Five strands of big blue beads with black beans between, dangle down the fur.

A cloak, probably made of Jackal skin, is tied on at the neck, and brass beads are sewn around the edge at the back. The cloak consists of strips of skin, the pieces placed together so as to form a striped cloak, and oversewn with sinew (6). The edge is folded back like a collar. Bending back the top edge of the pelt cloak (kaross) to form a collar, was a favourite way of wearing a kaross by the Sotho-Tswana peoples (6). From this brass bead border hang five strands of blue beads with a few black seeds, also a 4 in. tuft of white fur. Tied by sinew around the neck is a shrunken paw of a Cape Polecat (*iqaqa*) and a small tuft of fur. Both hang over the chest. Perhaps the tufts of fur represent animal tails, which used to be fashionable cloak adornments in 1822 (14). The polecat paw must be an amulet, probably intended to imbue the child with some virtue possessed by the animal (2). This doll is evidently wearing a kaross and a long skin apron (*Thetho*) still worn by the Sotho-Tswana tribes in the Transvaal and Bechuanaland (8), but they are put on with the attractive hairy side outermost, while traditionally the hairy side is worn to the inside, though indeed the kaross is sometimes worn hairy side outermost (8) though this may be due to the photographer's persuasion. The kaross was decorated with buttons, bits of brass or any ornament procurable by the Kaffirs (9). This example of Basuto kaross seems to show ideas of both tribes, having coarse brass beads around the collar and rows of beads and beans down the back, a fashionable way of arranging cloak ornaments among the Kaffirs of Barrow's day. The kaross and *thetho* are worn by married women and perhaps the doll thus indicates the new status of the bride. The strands which hang down to the shoulders of this specimen are perhaps meant to represent the twined strands of hair, after a fashion reminiscent of that of Burchell's day (14). Such headdress is not at present usual among the Sotho tribes.

Height	$5\frac{5}{8}$ in.
Diameter of base	$2\frac{1}{4}$ in.
Circumference of neck	4 in.
Length of thread tassel	$1\frac{5}{8}$ in.

Length of fur apron	5 in.
Length of bead dangles	$3\frac{1}{8}$ in.
Length of fur tuft	4 in.
Length of necklace	$2\frac{3}{4}$ in.

Specimen 2806 (fig. 9) is a fairly modern fertility doll from Basutoland and is made from clay. The cylindrical clay body is $1\frac{7}{8}$ in. in diameter at the base and tapers to the neck. The head is thrown back, modelled quite realistically out of the clay. A hole represents the mouth, while the nose and forehead are lumps on the face. There are tiny holes for nostrils and white beads pushed into the face for eyes. Little flaps set on the side of the head, are ears. On the top of the head are white and blue beads for hair, a strip of white in front and of blue behind. The back of the head is made up of threads matted hard with red clay. The whole face is rubbed with red ochre. The body is wrapped around in a piece of skin which is sewn up with sinew. A piece of string, stained with red ochre, is wrapped around the doll's neck. It was collected by Dr. J. Denfield at Quthing in 1947.

Height	$5\frac{3}{8}$ in.
Diameter of base	$1\frac{7}{8}$ in.
Length of face	$1\frac{1}{8}$ in.
Length of cloak	$4\frac{5}{8}$ in.

A modern type of fertility doll, *Specimen* 2805 (fig. 10) collected with the doll described above, is made out of the fibrous outer-scale leaves of an amaryllis bulb. A hank of these fibres is bent double, the rounded folded end then becoming the head of the doll, while the flaring loose ends become the skirt. A black and a white bead are sewn on the head for each eye, strands of blue, pink, green and navy beads are sewn on in a haphazard way as hair. To indicate the neck are two rows of blue beads. The torso is indicated by a band of multi-coloured lace beadwork, the beads being threaded to form diamond-shaped outlines rather like muslin or diamond mesh netting. The predominant colour is green, with lines of navy or blue running through it, and dots of red, white, or pink in the pattern. A row of pink beads denotes the end of the bodice The fibres form a thick skirt flaring out beneath this band of beadwork. A thread is tied around the doll's waist, from which hang, at intervals, strands of the fibrous material, tipped with white beads, which are kept on by a knot at the end of the fibre.

Height	$5\frac{3}{8}$ in.
Length of bodice	$2\frac{1}{4}$ in.
Length of skirt	$2\frac{3}{8}$ in.

Specimen 2266 (fig. 11) was used recently in Basutoland and shows European influence. A black wooden doll with movable arms and legs, it is in every detail of clothing an exact miniature of a little Bantu girl, and is skilfully carved out of wood. The whole doll is coated over with black boot polish. Although the doll is similar in make to European dolls, the physique of the doll is Bantu for example it has the typical distended abdomen of native children, and the features of the face are unmistakably Bantu -the bulging forehead, the indentation between the eyes, the wide nose and slight prognathism. The hair is also carved out of wood, incised lines running downwards from the crown in a sharply marked hemisphere at the back of the head. The arms are carved in a bent position, the fingers particularly being very carefully carved. They are nailed on to the body, loosely, so that they are movable. The legs are also carefully carved and cleverly fitted onto the body. The loins are carved like a rectangular block beneath the stomach, and the thighs have a wedge of wood cut away on the inside so that they fit against the rectangular part. A piece of stout wire is passed from the side of one thigh right through the rectangular part and out at the other thigh. The legs are also thus movable. Around one wrist, both ankles and both knees, are single strings

of white beads. Around the hips is a string of blue and yellow beads, and a thread fibre skirt (*tetana*), an exact miniature of those actually used. A yellow or blue bead tips the threads of the skirt, which are knotted at the ends. Around the thick short neck is a necklace of big red beads and Erythrina seeds, another of diamond-cut red beads between small white ones, and a third necklace of iridescent blue beads between a few tiny red and yellow beads hanging over the chest. A bead pendant hangs from this—a loop of white beads, with green, red and yellow beads interspersed, and at the bottom two little loops of white beads. From the ears hang different earrings. On the one is a loop of transparent beads with one green bead and beneath it a tiny loop of white beads. On the other ear is a loop of white beads with one blue bead. These loops of beads are threaded on cotton, and are hung on fine wire loops piercing the earlobes. It was presented by Mrs. M. Eckley in 1954, having been collected at Fouriesburg as a fertility doll.

Height	$13\frac{1}{4}$ in.
Width of head	$2\frac{1}{2}$ in.
Length of head	$2\frac{3}{4}$ in.
Length of arms	$5\frac{1}{2}$ in.
Length of legs	7 in.
Length of titani	$2\frac{3}{8}$ in.

Calling-the-Baby-Dolls

These dolls are charms which are very rarely seen today, and are utilised by women who have proven barren. A model of a baby carved out of wood is placed on the roof of her hut by a witch-doctor. They refer to this as "calling-the-baby" as though they were appealing to the ancestor spirits (*iminyanya*) to send a baby to that house. The custom is fast dying out. The specimen in the East London Museum was collected by Dr. Mima Trollip, who attended a woman near Idutywa who for years had been barren. The doll was carved by a friend of the woman's husband, and placed on her hut by a witchdoctor, and was later given to Dr. Trollip for attending her, about 1939. This is a custom which was common among the Xesibe (a tribe closely related to the Pondo, also of Ambo stock) as late as 1944, when three wooden dolls, highly polished and of dark wood, were seen by Miss M. Courtenay-Latimer on the apices of the owners' huts. These dolls have a very tenuous life, being placed on the hut until the baby arrives, and then burned and buried with the afterbirth and any soiled clothes. Thus they are almost unprocurable by Museums, except under very unusual circumstances. This custom of the Nguni tribes is not the same as the related Basuto fertility custom. It is not carried by a bride, and not made before the wedding. It is only made after the woman has proven barren. The information concerning this custom was given by the people practising it.

Specimen 2969 (fig. 12) is the statuette of a little boy on a pedestal, carved out of a log of stinkwood and highly polished, the pedestal being a somewhat uneven cylinder. The head is heavy for the body, is almost perfectly spherical and thrust forward. On this ball-like head the ears are carved out at the sides—they are round and raised from the head at the back. The features are set close together at the front, within an area of about 2 in. long by $2\frac{1}{4}$ in. wide. There is some indentation to indicate a prognathous mouth, and the hollows around the nose. The eyebrow is indicated by sharp indentation above the eye, sloping outwards again in the eyelid, to the long hollows which are the eyes. The nose is straight and rounded over the bridge, and the mouth is another long hollow. Although the back of the head is almost in a line with the back, the chin, which is but slightly marked, juts out $1\frac{1}{2}$ in. from the chest. The body is only 2 in. through the middle, in comparison to the 4 in. thickness of the head. The body gently increases its girth from the neck downward. The shoulders are not distinct, for the figure has only a little lump on each side of its body for arms. The buttocks are not accentuated, but the penis is carefully carved. The legs are shaped,

but are out of proportion, being quite narrow at the thigh, increasing in width to the knee. At the calf the leg is $2\frac{5}{8}$ in. wide, tapering to the ankle. The feet are joined. The legs are slightly apart.

Height	$32\frac{1}{4}$ in.
Height of pedestal	$7\frac{1}{4}$ in.
Width of pedestal	$5\frac{1}{2}$ in.
Length of head	4 in.
Width of head	$3\frac{5}{8}$ in.
Width of body	2 in.
Width of hips	$4\frac{1}{8}$ in.
Width of thighs	2 in.
Width of knee	$2\frac{3}{4}$ in.
Width of feet	$3\frac{1}{4}$ in.

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NOTES

M. COURTENAY-LATIMER
EAST LONDON MUSEUM.

Two rare seal records for South Africa

On the 15th September, 1946, Mr. Clem Gibbard brought in an animal which he stated had been found on the beach at Paarde Kraal, fourteen miles north-east of East London. This specimen was identified as a Female Leopard Seal, *Ogmorhinus leptonyx*. It was mounted and is on exhibition in the East London Museum.

These seals are known to inhabit the Antarctic where they occur usually alone on the pack ice. This exhibit is possibly one of the few of this animal anywhere in the world.

On the 22nd July, 1957, Mr. Searle of Anglers Inn at Hamburg informed us that a quaint animal had been found on the beach, which proved to be a Female Crab-eating Seal, *Lobodon carcinophaga*. These seals also inhabit the Antarctic and are found on the pack ice in small parties.

Both these specimens were the first to have been recorded in South Africa, and it is interesting to know that specimens of this nature do occur on our coasts. As far as can be ascertained they are the only specimens of their kind in any Museum in South Africa. Many rare animals must be lost to the scientific world through people who do not take the trouble to report finds to the nearest museum.

CONTENTS OF VOLUME I